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PLATE XXXIII.

A. J. I.

FIG. I.—ALFALFA. a. b. SEED POD.

Natural Size

FIG. II. ALFALFA SEED.

LUCERNE OR ALFALFA CULTIVATION.

By E. THOMPSTONE, B.Sc.,

Principal, Agricultural College, Burma.

ENQUIRIES are constantly being made, especially by Europeans and others who keep valuable horses and ponies in India and Burma, regarding the cultivation of this excellent forage crop. In this article a short summary of the most useful and interesting information will be laid down, without the addition of any laborious figures or details of experiments which might be included in support of the statements.

History and distribution.—Although Lucerne (*Medicago sativa*) is known to have been cultivated in India for at least 100 years, it is generally believed that its cultivation does not extend back for a much greater period. De Candolle, however, in his "Origin of Cultivated Plants" says (page 103): "It has been found wild, with every appearance of an indigenous plant, in several provinces of Anatolia to the south of the Caucasus, in several parts of Persia, in Afghanistan, in Beluchistan and in Cashmir..... The Greeks may, therefore, have introduced the plant from Asia Minor *as well as from India*, which extended from the north of Persia. The origin of lucerne, which is well established, makes me note as a singular fact that no Sanscrit name is known." To the south of Europe from where we have the first records of its cultivation, over 2,200 years ago, it is generally supposed not to have been indigenous but to have been introduced from Media, at the time of the Persian war about 470 B. C.—hence the Greek name "Medicai" and the Latin name "Medica" or "Herba-medica." From that date it is known to have been largely cultivated around the Mediterranean Sea—on the North in particular, and more especially in Spain whence it was introduced into Mexico

at the time of the Spanish Invasion and thence to South America.

It was later introduced into North America from Europe, but it also spread upwards from the South through California. It is now spread over North America and a great part of South America. In the North it can be grown in the cold regions of Canada and there produces heavy crops during the summer months. The name "Alfalfa" is derived from the Arabic—and the name "Lucerne," at one time supposed to come from the valley of Lucerne in Piedmont, Switzerland, is now generally supposed to be derived from the Patois name in the South of France—laouzerdo; the plant was introduced into that part of Switzerland only within comparatively recent times.

It will be seen from the above that the cultivation of this plant is very widespread. It can now be found widely distributed on all the continents of the world, and almost everywhere it is known it is a favourite fodder crop both for forage and for making hay. In India it is more generally found around Cantonments and other places where horses are kept, such as rearing and remount depôts. In Burma it is not by any means unknown and its cultivation throughout the Indian Empire is rapidly extending.

Description and Habit of the Plant.—Lucerne (often called "Lucerne grass") is not a grass but belongs to the large family of plants known as Leguminosæ (Bean and Pea family) which includes a great number of very valuable cultivated plants. Clover belongs to this family, and Lucerne, though not a true clover, resembles it very much; it belongs to the genus Medicago, whilst clover belongs to the genus Trifolum. Its fruit is a legume or pod of peculiar twisted or spiral shape (Plate XXXIII, Fig. I, *a* & *b*); and each fruit contains 5 to 8 small seeds of a yellowish-brown colour. Fig. II of the Plate shows seeds natural size and enlarged. The plant is somewhat slender, upright, branching and smooth (Fig. I). It grows from 1 to 3 feet high and is a perennial, which will continue to thrive under favourable conditions and good treatment for 8 or 10 years, producing a large bulk of fodder every year—20 to 25 tons green food or 3 to 5 tons hay. In India, how-

PLATE XXIV.

A. J. I.

FIG. I. ALFALFA SEEDLING. 6 WEEKS OLD.

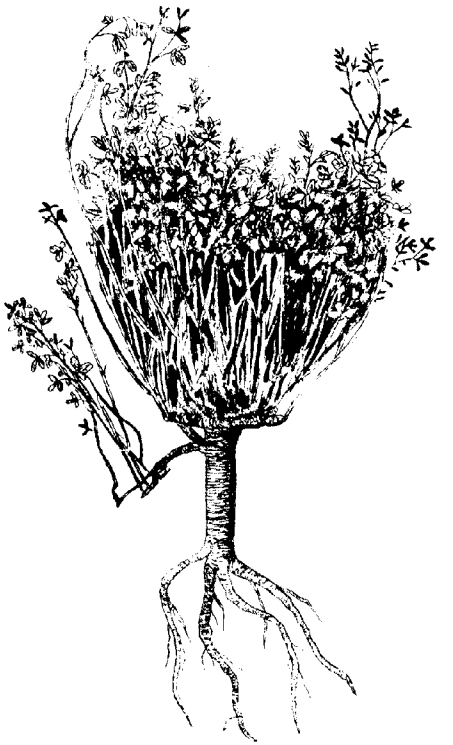

FIG. II. ALFALFA. 3 YEARS OLD.

ever, it seldom thrives well for more than 5 or 6 years ; and when it is allowed to run to seed, it does not, as a rule, live so long as when continually cut before the seeding stage is reached. Just how long it may be profitably left for cutting depends largely upon the state of the soil and the treatment the crop receives. A crop well established may often be cut 6 or 8 times in a year. The roots of lucerne plants descend to a great depth where the soil is loose and permeable—often averaging 10 or 12 feet. Roots 50 to 66 feet have been recorded in some places. By means of its deep roots it is able to feed and obtain moisture from the deeper layers of the soil. In this way it often successfully resists drought in places where it is grown without artificial watering. In hot countries, however, it gives its best results under irrigation. In the young plant, springing from the crown of the root, there is a simple basal stalk which gives rise to a number of low branches ascending directly from the ground and forming a small compact tuft (Plate XXXIV, Fig. I). But when the plant is cut or eaten off, the stalk dies down to the very base and produces buds from the upper part or crown of the root, forming new stems in a dense cluster as will be seen from Fig. 2 of the Plate. On the other hand, the stems of many other forage crops, when cut or broken off, immediately branch out above ground forming lateral shoots. Continuous close grazing, on account of this peculiar habit, often kills lucerne.

In common with other members of the Leguminosæ family, lucerne enriches the soil in atmospheric Nitrogen. This it does by the aid of the bacteria contained in the nodules on its roots, the decay of which renders the nitrogen available for other plants. The decay of the long tap-roots and other roots tends to improve the soil in texture—especially if the latter is stiff.

Uses of the crop.—Its chief uses are as a forage crop and for making into hay. Europeans and many others in India are quite familiar with the value of lucerne as food for horses, to which it is generally fed green, though sometimes it is made into hay and stored. It is said to be specially valuable for race horses and often near towns commands a high price (even as much as Re. 1

per 80 lbs.)—a fair crop often realising Rs. 40 to Rs. 50 per acre at one cutting. With good irrigation facilities over 83,000 lbs. of green fodder have often been obtained in one year.

Not more than 10 lbs. per day of lucerne should usually be given to a horse ; and in starting to feed on Alfalfa in any form, it should be given in small quantities at first, as injurious effects are liable to follow a too rapid change.

Although lucerne forms a good food for milch cattle, it must not be fed too liberally, especially in the green state, as it is liable to cause tympanitis. Ten lbs., the daily allowance for a horse, is also suitable for a cow. It also makes a good food for other animals, and in America is largely fed to poultry and pigs, which are allowed to pasture on it. Other uses to which a crop is frequently put are green manuring, orchard cover-crops, silage and seed production. By the use of this crop and a proper arrangement of the beds, a continuous supply of green food can be maintained almost throughout the year.

Varieties.—There are a number of varieties of Alfalfa found in Europe, Africa and elsewhere, but only two or three are generally cultivated in India. The Persian or Arabian variety appears to be the most common, though the Turkestan and a variety called 'Kandahar' are also found. It appears to have been the experience of some, that plants grown from newly imported European seed do not thrive so well, especially during the first year and on the plains ; therefore acclimatised seed is often spoken of as being most satisfactory.

Climate.—Although lucerne cannot survive extreme cold, it is not readily killed by frost and is often found thriving splendidly at high altitudes and in countries where the winter is moderately severe. In hot countries it is found up to 8,000 feet high in mountainous regions. So long as there is sufficient moisture in the soil, heat and the sun's rays do not do the plants any considerable amount of damage.

Rainfall.—Although a well-established field of lucerne can withstand drought to a large extent, in countries of insufficient rainfall, the growth is limited unless water can be suppiled by

irrigation. The average rainfall requirement of the crop is probably about 20 to 22 inches per year, apart from the water required to replace that which is constantly being evaporated from the soil surface. In hot countries where surface evaporation is very great, much more water will be required than in colder countries. A great deal also depends upon the distribution of the rainfall, upon the capacity of the soil to take in and hold water, upon the depth of the permanent moisture below the surface, upon the presence and absence of seepage water from surrounding areas and upon other conditions, local and climatic, which affect the water-supply or the rate of evaporation, so that only approximate figures can be given for the necessary rainfall. Where the rainfall is very small and at the same time irregular or badly distributed, very little success can be expected without irrigation.

Soils.—The most suitable soil is a loam resting upon a well-drained, porous sub-soil which will allow the roots to penetrate deeply. Lucerne will, however, grow on almost any soil from sand to a stiff clay provided that it is deep enough and that the drainage is sufficient to carry off the surplus water. As a rule, this crop cannot withstand being submerged for more than about 48 hours—excess of water is fatal to the plants. Sandy soils often require much manure and stiff clay soils are generally unsuitable to irrigation. It is very important that lime should be present in the soil.

Cultivation.

Preparation of the land.—This should be carried out by ploughing deeply, if with a native plough five or six times—2 or 3 months before it is time to sow the seed. Harrow well until a fine tilth is obtained, removing all weeds and rubbish. If the soil is hard and lumpy, it may be necessary either to wait until rain comes, or to run on a little water in case of irrigable land, in order to soften the hard lumps so that they may be pulverised. If the soil is wet by rain after being prepared, and is then harrowed as soon as it is dry enough to work, an excellent seed

bed is generally the result. Before ploughing, well-rotted manure should be applied if it can be obtained, at the rate of 30 bullock cart loads (say 10 to 15 tons) per acre. This should be well mixed with the soil whilst ploughing and harrowing. Manure which is not rotted is unsuitable as it keeps the soil too open, attracts white ants and is not in a fit state for the plants to make use of at the time when they most require it.

Time to sow.—The best time for most districts is either early during the rains or at any time from October to December. In the North, in the hills and in the less warm districts the best time will probably be found to be during October and November. It is in these places that the crop usually does exceptionally well. In countries where frosts occur it is generally sown after the frosts are over and the soil has become warm. Alternate freezing and thawing often heaves the plants out of the ground especially when they are young, so that the seed should not be sown when frost is liable to occur shortly afterwards. The land for lucerne cannot be too well prepared and it is absolutely necessary to have it free from weeds so that it is better to start the preparation in good time.

Seed.—The cost is high, ranging in India from annas fourteen to rupee one and annas eight per lb., so that good seed should be carefully chosen. It can be judged to a certain extent by careful examination. Good seed should be of a bright, glossy nature, yellowish to brown in colour, plump and well formed, without broken seeds and without holes made by insects. Though not absolutely necessary, if the seed is obtained from a reliable source, it is a safe plan to test the germinating power. This can be done by counting out a number of seeds placing them between moist flannel (which must not be allowed to dry and must be kept warm) and counting the percentage which germinate. If the percentage is low, more seed should be sown accordingly on a given area.

Quantity of seed to sow.—Depends largely upon the method of sowing which is adopted. It will be stated in the following paragraphs.

Methods of sowing and laying out land.

1. Without irrigation the method is simply the same as that of sowing any grain crop, but can, of course, only be carried out where the rainfall is sufficient. After the land is prepared and ready to sow, the seed may be sown (*a*) broadcast; (*b*) by means of a drill; or (*c*) in rows by hand.

(*a*) Broadcast sowing is the most expeditious method, but is most wasteful of seed and in other ways not so satisfactory. The seed is simply scattered and the land then harrowed in order to cover it. Nothing further is required except to keep the land free from weeds, which is by no means easy after this method of sowing. About 20 lbs. of seed are required per acre (that is, 1 lb. will sow an area about 15 yards by 16 yards).

(*b*) Drill sowing is almost invariably carried out in America and has many advantages over broadcast sowing, *viz.*, (1) the seed is distributed more evenly than can be done by hand; (2) the seed is deposited at a uniform depth in the soil, though with small seeds like lucerne care must be taken not to bury the seed too deeply; (3) less seed is required; (4) the crop can be weeded and kept clean much more readily, and as weeds are the greatest enemies of a lucerne crop, this is an enormous advantage. The quantity of seed required when sown in this way is usually about 15 lbs. After sowing, the seed is often covered by means of a very light brush harrow or a light plank drag.

Note.—The Native drill sower does not possess all the advantages of a European or American drill: but its careful use is nevertheless to be greatly preferred to broadcast sowing. When this implement is used, the seed may be well mixed with dry sand or other substance to give it bulk and to assist in its even distribution. With this implement very great care is necessary not to allow the seed to be placed too deeply in the soil.

(*c*) By hand. This is the most careful and least wasteful method, but at the same time it is slow and tedious. It is undoubtedly the best for small and moderate-sized areas. There is still greater saving of seed, requiring about 12lbs. per acre. Parallel grooves are made by means of a stick, hoe or other con-

venient implement at the required distance apart (say 15 to 18 inches); and the seed carefully sown by hand in these grooves. It is then covered with about one inch to one-and-half inches of fine soil and, when the plants are well up, weeding operations are carried out between the rows.

It is customary in many parts of Europe and America to sow the lucerne seed with a grain crop (usually barley). By the time the grain crop is harvested, the lucerne has become well established. This is not an advantage, at least from the standpoint of the Alfalfa crop and is seldom if ever practised in India.

II. *Sowing irrigated areas.*—(*A*). The native method of sowing is to lay out the land in small beds divided by low bunds. The area of each bed is often about 100 square feet (sometimes a little larger); and the arrangement is a double line of beds divided by a water channel. The areas and arrangement of the beds are, however, generally determined by the evenness or otherwise of the land surface. These beds are well prepared and the seed is sown broadcast at the rate of about 16 to 20lbs. per acre. A kind of wooden rake is then used to scratch over the surface and so cover the seed. Water is allowed to flow from the water channel over the surface of each bed in turn, and irrigation is carried out every six to twelve days according to the season. During the rains, except when breaks occur in the monsoon, no water is given; whilst in hot weather the waterings are frequently given, and in the cold weather they are less frequent. This method of culture is not to be recommended, because, although heavy crops may be obtained for two, or even three years, the land cannot be properly weeded and gradually gets more and more foul until the crop absolutely fails at a time when it should be producing the heaviest cuttings. Lucerne is easily crowded or smothered out by weeds—hence the necessity for arranging the crop so that the weeding operations may be readily and carefully carried out. As the cost of starting a field of lucerne and that of maintaining it in good order by the aid of manures and by weeding, are both heavy, it is important that a crop, once established, should be made to hold out as many years as possible, so that the initial

expenditure may not recur too frequently. Moreover, this method has the disadvantage of having the water run over the surface. This manner of applying water should, if possible, be avoided for several reasons :—(1) when the plants are young, many of them get washed away or otherwise destroyed unless the water is very carefully and slowly run into the land; (2) it is not always easy to run exactly the right quantity of water into a plot, and excess water—especially stagnant water—as already pointed out, is fatal to lucerne plants. The correct quantity of water is more easily gauged when running it into a furrow, which may be filled to a certain level, than when running it over a flat surface, and any excess can be more readily run off at the other end of the furrow : (3) on stiff soil in particular (and on other soils too which are liable to bake rapidly) if water be run over the surface; as it dries, a thick hard crust is rapidly formed which not only injures the existing plants but absolutely defies young shoots or young plants to push their way through it. Such a soil, if watered by the furrow system, does not bake at the surface in the same way, unless the water be allowed to overflow the furrows. A good example of this kind of soil exists round Mandalay (and also at many other places in Burma) where in two or three days after the water has flooded over and left the surface it has formed a crust impenetrable to young seedlings; (4) lucerne, as previously explained, has deep roots and feeds from the deeper layers of the soil, so that it is unnecessary, if not actually injurious, to run water over the surface soil; (5) by the furrow system the application of water can be more rapidly and conveniently carried out.

(*B*). Another method of cultivation is as follows :—

The land is first cleaned, cultivated and manured in the usual way and the seed scattered on the surface, at the rate of 16 to 20lbs. per acre and lightly harrowed in. Single furrows are then made by means of a plough at right angles to the water-supply channel, and as nearly as possible at equal distances apart. Other furrows may then be made at right angles to the first set of furrows and parallel to the water channel. The land is thus divided up by means of furrows into nearly equal-sized square or

oblong plots which can be watered by running water into the furrows without allowing it to overflow the surface. The distance apart at which the furrows should be made depends entirely upon the kind of soil and the rapidity with which the water will percolate from the small channels to the centre of the plots. In soils where percolation is slow, the furrows must be close together, and where percolation is rapid, they may be far apart—a convenient distance is 6 to 8 feet. The second set of furrows—parallel to the water-supply channel—may be omitted and the land thus left in long strips. For convenience and rapidity in applying water, however, especially where the land is slightly uneven, it is often advisable to make these furrows. The small quantity of soil turned out of the furrows may bury a few seeds too deeply for germination ; but the damage done in this way will be very small and the soil may afterwards be levelled off by hand—most readily and with least injury after the first cutting of lucerne. It is often carefully levelled off at once.

In making the furrows an ordinary native plough may be used ; but a better furrow is made by placing a V-shaped board in the angle of the plough and fastening it there by means of a bolt or by means of a cord passed through two holes in the board and round the body of the plough. A convenient size for the board is about 15 to 18 inches wide at the top, with depth according to the plough to which it is attached. For smaller furrows a narrower board must be used. A Burmese or native plough adapted in this way may be used for making furrows or ridges for many crops, and a bullockman soon learns to go straight when using it. A Burmese plough as used at Mandalay is shown (Plate XXXV, Fig. 1). On small areas the spade, hoe or mamootie is often used to make the furrows, but for large areas this is laborious and costly.

This method of cultivation has advantages over method A in that the irrigation water is not made to flow over the surface and that it is more rapidly carried out and so specially suited for large areas. It, however, has the same objection as method A with regard to the suppression of weeds and cannot be strongly recommended for that reason.

PLATE XXXV.

FIG. I.—BURMESE PLOUGH ADAPTED TO MAKE FURROWS OR DRILL.
SCALE $\frac{1}{2}$ INCH TO 1 FOOT.

A. J. I.

FIG. II.—DODDER PLANT ON AN ALFALFA STEM.

(*C*). An improvement on method (*B*), which could be really carried out on small and medium-sized areas, would be to make the furrows, as already described, before sowing the seed and then, after levelling off the plots by hand, to make parallel grooves, by means of a hoe, stick or any convenient implement, 15 to 18 inches apart and one to one and-a-half inches deep and sow the seed carefully by hand in the grooves. This would effect a considerable saving in seed, about 12lbs. per acre only being necessary, and at the same time the crop could be suitably watered by flooding the furrows and the land kept clean by hoeing and weeding between the rows. This method is one to be recommended.

(*D*). The method which in most cases will meet with the greatest amount of success is that of sowing the seed on drills or ridges. The land, which is cleaned, manured, well ploughed and harrowed in the usual way, is formed into ridges by means of a plough—or on small areas by the spade. The adapted native plough already described is a most serviceable implement. The ridges may be about 22 to 28 inches wide from centre to centre or from bottom of one furrow to that of the next. When only one row is sown on each drill (the most common method), a twenty-two inch drill is wide enough; but when two rows are sown on a drill, as occasionally happens, it is better to make the drills 36 inches wide and sow the two rows 12 to 15 inches apart. The drills should be drawn at right angles to the water-supply channel and should be made not less than 6 inches high from bottom of the furrow. Have the soil on the top of the drills or ridges well pulverised, and sow the seed by hand in grooves (made as previously described) on the top of the drills, covering with an inch or so of fine soil. The seedlings spring up in lines, the sides of the drill and the space between the lines can be readily weeded or hoed: and a horse or bullock hoe may be used if desired. Moreover, this method effects a great saving of seed,—only about 10lbs. being required for one acre,—and the stems of the small delicate seedlings are raised where the water does not reach them.

AFTER-TREATMENT OF THE FIELD.

It has been previously stated that a field of Alfalfa will continue to produce heavy and profitable crops for a good number of years if properly treated, and it does not reach its maximum development until the third or fourth year after planting; yet under improper treatment it is frequently exhausted and ceases to yield profitably about the time it should be at its maximum.

Care of the field—Lucerne is seldom if ever used for pasture in India, but if a field is intended for this purpose, it should not be grazed the first year, but cut down and either fed green or made into hay. The second year there is not the same danger of injury from trampling or close grazing, and in some parts of the world it is frequently seen as a pasture plant for cattle and horses. In parts where the winter is at all severe, it should never be cut too late in the season, the last cutting before the winter sets in being taken at such a time as to allow at least a 6-inch growth to take place; or the crop is liable to suffer from frost. It is most important to obtain a good, even stand of plants the first year. If this does not take place, the bare spots may be carefully resown, but if the field is very bad, it is better to plough up and reseed entirely. Where irrigation is carried out, however, a poor field may very often be greatly improved by "patching" with seed or even by removing roots from the thickest parts to the bare parts. In America if a field becomes patchy or requires rejuvenating, as often happens on compact sod after a few years, it is the custom to thoroughly disc the sod with a disc harrow so as to split the crowns of the plants: then to sow seed on the bare patches and finally to harrow well with the ordinary harrow. This can of course only be carried out where lucerne is sown on the flat, but after such rough treatment a well-established crop seems to thrive even better than before.

Cutting the crop—The proper stage at which to cut the crop either for green food or for hay is when the plants are beginning to bloom. After that time the produce rapidly deteriorates in nutritive value, and before that period the maximum amount of

produce cannot be obtained. It may be cut close to the surface of the ground with any convenient implement.

Irrigation—Although the best crops are undoubtedly produced by giving a liberal supply of water, it is often found that where the supply of water is limited, a small quantity will produce paying crops.

The minimum amount of water that will produce a paying crop and the time when the water should be supplied, depend largely upon the soil and climate. In many places, as already explained, it is grown without any artificial supply, but in India this is not often the case. When the plants are young and also during the hot weather frequent waterings are necessary. On light soil too water is required more frequently than on heavy land. In America it is the custom to water every three or four weeks only; but in parts of India water is given every ten days during the cold weather and every 6 to 8 days during the hot weather. At Surat in Bombay good crops have been obtained by supplying water every 15 days, less frequent waterings giving poorer results. In the rainy season the crop may require water only during breaks in the monsoon. By a little observation and examination of the soil, the grower can decide for himself when water is necessary and an intelligent man will often succeed better in this way than by irrigating, as it were, by rule of thumb, at regular stated intervals. A plant which does not "flag," or which "flags" very little, during the heat of the day, and the soil which is moist at a short distance below the surface are not in need of water. Two points to be remembered are, never to allow water to lie on the surface for any length of time, and secondly small quantities of water at short intervals are usually better than large quantities given after long intervals.

Weedings—Weeds are the greatest enemies of the Alfalfa crop, especially in damp regions and on irrigated land. The young plants are readily crowded out and even old plants soon die if the weeds are not removed. In sowing the crop in rows the principal object aimed at is to facilitate the weeding operations. If the field is well cleaned before sowing, the expense of

weeding is minimized, but if weeds grow apace, the only way to obtain a good crop is to constantly hoe or weed by hand. Hoeing and loosening of the surface soil, even though not necessary for the purpose of eradicating the weeds, are beneficial to the growth of the plants. A bullock hoe or scuffler used between the rows after each cutting is often very useful and saves labour.

Manuring—Lucerne cannot be very profitably grown without manure. After every three or four cuttings, a liberal dressing (say, at least 5 or 6 tons per acre) of cattle or horse manure should be applied. If the crop has been sown broadcast, or in rows, spread the manure over the surface; if sown on ridges, spread along the drills and by using a bullock hoe or grubber stir up the soil so as to incorporate the manure with it. On small areas it may be dug or hoed in by hand. Only well-rotted manure should be used, and if this is not available, give a dressing of about 4 or 5 cwts. per acre of cotton cake or castor cake. In Burma cotton cake is available, but if castor cake is desired, it must be obtained from India. There is not much difference between the compositions of the two. A crop well treated in this way should yield a cutting at least every 6 or 8 weeks and should continue to do so for years.

Lucerne for seed—As the seed is so expensive to buy, it is often desirable and cheaper to save the quantity from one's own crop. Good seed can readily be obtained by judicious watering and careful harvesting. A field of about the second or third year's growth is best suited for this purpose—seed should never be obtained from a very young field. After the cold weather has begun and a crop has made a fair amount of growth, water sparingly so as to encourage the formation of flowers. If too much water is given, the plants run to foliage rather than to seed.

When the seed is beginning to ripen, the water should be withheld until after the crop is harvested. The seeds are ripe when the pods have become dark brown; and the crop should be cut when fully half of the pods have assumed this colour. Cut the crop very carefully and do not shake the plants more than necessary so as to lose as little of the seed as possible. It may be

tied into bundles and should be removed at once to a drying floor from which seeds afterwards lost during drying may be gathered up. When dry, the seed may be beaten out by means of sticks or thrashed out by any ordinary thrashing machine. The straw which is left makes excellent fodder. After thrashing, it will be found that many broken leaves are mixed with the seed. These may be removed by winnowing in the ordinary way employed for winnowing grain ; and they also make good fodder. Upwards of 300lbs. of seed are usually obtained from one acre, and the yield may rise as high as 600lbs. It takes about twice as long to produce a crop of seeds as it does to produce a crop of fodder.

Lucerne Hay—If properly prepared, lucerne hay is as good as the best clover hay. In America lucerne is very largely used for this purpose and is considered by many superior to clover. It should be cut when it is beginning to bloom and allowed to dry before it is put into stacks. It should be handled as little and as carefully as possible, or the leaves, which are the most nutritious part of the plant, are shattered and lost. In hot countries it very rapidly dries : and when thoroughly cured, it may be made into stacks or baled in the ordinary way. The whole process is extremely simple : but care must be taken to cure it well or heating takes place in the stacks or bales. The best lucerne hay is of a bright green colour, but its colour is readily changed to yellow or brown by the effect of rain or even dew, and by heating in the stack.

Pasturing—A field of lucerne forms a good pasture for all kinds of animals. Horses do well on it, but are liable to injure the stand of Alfalfa by trampling or close grazing. Cattle or sheep, when first turned on to a field of this forage, require to be closely watched as they are very liable to suffer from "Bloating" or tympanitis. As already pointed out, lucerne should not be closely pastured. In India it does not appear to be used for this purpose.

Soiling—When cut green and allowed to wilt slightly, lucerne is one of the best and cheapest foods that can be given to horses or cattle. It is commonly fed to dairy cattle and is said

to be one of the most nutritious and palatable foods for this purpose. About 10lbs. per day may be fed to a horse or a cow. In pig feeding it has also proved to be an excellent food.

Silage—For this purpose there appears to have been very little experience so far recorded, though it has been tried and proved useful when properly stored. After cutting, it is immediately carted to the silo, chaffed and well packed in. Water is even added in some cases.

Enemies of Lucerne.

1. Weeds form one of the worst enemies.

2. Dodder, a parasitic plant having numerous orange yellow-coloured thread-like, twining stems, which attach themselves to the lucerne plants, sending in suckers and gradually strangling the plants (Plate XXXV, Fig. 2). This is often seen in patches, here and there in the field. The remedy is to dig up the patches and destroy by fire all plants (root and stem) on which the dodder is found. It spreads rapidly and may soon destroy the whole field.

3. A fungoid disease of the roots which is often very destructive during a wet season. This also appears in patches which should be ploughed up. At Poona in a case of this kind a good mixed crop was produced for two years by planting guinea grass on these diseased patches. There is no known remedy, and if the disease is very bad, it is better to plough up the field and not plant lucerne there for a few years.

4. Rust or spot disease of the leaves *(Pseudo peziza medicaginis)*. This is characterised by the turning yellow of the plants and the appearance of small black spots on the leaves. It may be overcome to some extent by cutting and good manuring—producing a vigorous growth. There is no real cure, and if it become very bad so as to considerably reduce the crop, plough up the field and sow your Alfalfa on land which is free from the disease. As the latter lives in the soil, this is the only preventive measure

THE SAIDAPETH AGRICULTURAL COLLEGE AND FARM.

By C. BENSON, M.R.A.C.,

Late Deputy Director of Agriculture, Madras.

THIS Institution has now, after a chequered existence of over forty years, been closed. Its history is connected with the work of the Agricultural Department of Madras and the earlier efforts of Government towards Agricultural improvement. Some account of its early days may, therefore, not be without interest. Its work was then alluded to as typical of what should be done in India in the cause of agricultural advancement, and visitors came from all parts of India to consult its Superintendent, Mr. W. R. Robertson, M.R.A.C. The history of this farm will afford enlightenment on various points connected with the correct establishment of Government farms.

In 1863 the then Governor, Sir William Dennison, drew attention to the practice of cropping without rotation, to deficient manuring, to the extensive use of cattle manure as fuel and to defective implements and cattle. He suggested the importation of improved agricultural implements, and accordingly a steam plough, a variety of smaller ploughs, harrows, cultivators, seed-drills, horse-hoes, threshing machines, winnowers, chaff-cutters, waterlifts, etc., were obtained from England.

About this time the Collector of Madras (Chingleput) started a "Model Farm" of about 350 acres at Saidapeth which had recently become Government property, "partly with a view to demonstrate the value of the new implements to the satisfaction of the ryot and to remove native doubts as to the advantages derivable from them, partly to test various manures, partly to exhibit an improved system of agriculture." These views

were endorsed by the then Secretary of State, who expressed a hope for "a continuance of this interest in a question so closely allied to the welfare of the people."

The management of the farm was first entrusted to a Committee of gentlemen interested in the work who placed a Superintendent in charge on Rs. 75 a month. The post of Superintendent changed hands four times in the first two years, and as this was highly unsatisfactory, the Committee decided to get from England on a salary of Rs. 200 a month "a highly educated farmer, acquainted with agricultural chemistry and machinery and possessed of a thorough practical knowledge of all farming operations, and the management of cattle, sheep, etc." But the man obtained turned out "to be an ordinary farmer, without any scientific education, wedded to his own ideas and opinions, and carried on the business of the farm just as he thought proper, with very little regard to the instructions given him." After eleven months' trial, the Managing Committee found him unfit for the post and had to make temporary arrangements again for carrying on the work.

In November 1868 the late Mr. W. R. Robertson arrived to take up the post of Superintendent. The Committee soon found that he was "exactly the man they wanted," and from that time forward, the work at Saidapeth was Mr. Robertson's work. In 1871 the Managing Committee ceased to exist, and the general supervision of attempts towards the advancement of agriculture in Madras was entrusted to the Local Board of Revenue, and the actual management to Mr. Robertson. About this time, and largely as a result of the efforts of Mr. Robertson, the Government of Lord Napier resolved on a comprehensive scheme for starting experimental farms in various parts of the Presidency. This scheme is only now, 35 years later, being put into effect, but that Mr. Robertson's work was appreciated is shown by the fact that in 1878, the Government of India, in the course of a general review, recognised that in Madras there was already a Department of Agriculture and held that its expansion was impeded mainly by want of funds.

As a preparation for the study of Indian agriculture, Mr. Robertson had the advantage of experience among Irish peasant cultivators, but in his first eight years in India he was greatly handicapped by the fact that he had no opportunity of making himself acquainted with agricultural practices and conditions in Madras as a whole, while the site of the farm at Saidapeth had been unfortunately selected in a locality which did not represent any ordinary agricultural conditions in the Presidency. Geologically the soils are derived from alluvial deposits, probably estuarine, and their "general character is that of pure, or nearly pure, silicious sands," though beds of black clay occur below the surface, and in one or two places they crop out on the farm, whilst a ridge of metamorphic rocks runs through the southern portion of the estate and crops out in two or three places. This ridge has a considerable influence on the underground water-supply derived from the Adyar river which bounds the estate on the south and on the east where it is tidal and salt. The soils are deficient in the power of absorbing and retaining moisture, and on wetting they decrease in bulk considerably, and when they again dry, they become very hard, especially at the surface. Their composition is shown in the following analysis :—

Constituents.	Field No. 1* Surface soil. %	Field No. 4* Surface soil. %	Sub-soil. %
Alumina	3·24	4·12	2·060
Oxide of iron	1·35	1·80	2·900
Phosphate of lime	0·12	0·24	0·099
Carbonate of lime	0·31	0·70	0·560
Carbonate of magnesia	Trace	Trace	Trace
Sulphate of lime	Trace	Trace	Trace
Chlorides	0·90	1·08	0·720
Organic matter	2·12	2·50	1·740
Moisture	2·09	2·76	1·420
Sand	89·87	85·90	90·400

These fields represent some of the best of the land on the estate, and there the outcrop of the estuarine clay considerably influences the character of the soil, and the "sand" found is extremely fine in texture. The greater part of the estate is thus

* These field numbers are those used in the map published in the "Records of the Saidapeth Farm," 1885; they were altered later on.

described by Dr. Voelcker: "It has a poor hungry sandy soil, and the land is little better than a great sand-hill" and "ought never to have been selected."

In 1871 the site of the farm was condemned by General Cotton who had taken a prominent part in the selection of the implements originally brought out and who as early as 1868 had pressed on the Government of Madras the necessity for a special department to be entrusted with agricultural improvement "in all parts of the country," so that Government should "not be dependent upon the scanty leisure or casual half-hearted efforts of untrained persons, whether Collectors or their delegates." The main grounds of his indictment of the farm were that "neither the extent nor the variety of soil render it sufficiently typical for a Central Farm, nor were the irrigation facilities such as to enable the great questions of the value and use of water to be properly asked and answered"; but Mr. Robertson who at that time anticipated the early start of the above-mentioned scheme of district experimental farms defended the retention of Saidapeth mainly, it is believed, for its nearness to the head-quarters of Government, and his defence was accepted.

In the early days of the farm a great deal of attention was devoted to implements and machines. In their very first report the Committee remarked that though their trials had been incomplete, they had proved, on the whole, highly satisfactory and led them "to hope that ryots of this Presidency would soon learn that the extensive use of English implements and machinery in the cultivation of the land was certain to be attended with great advantage." In this they were mistaken. With ploughs the early experience was unsatisfactory. A windmill with throw pumps was also tried and failed; for in the still season of the year it was almost useless. A bucket pump (by Burgess and Key) was, however, tried with better result, and figures were published to show that it lifted water at scarcely one-third the cost involved in using the *picotta*. For chaff-cutters a demand soon sprung up, and one of the winnowers imported was said to be much applauded. In 1866-67, a steaming apparatus for preparing cattle food was

imported, but its later history is not clear, though a story regarding it is worth recording. One day one of the numerous amateur authorities on agriculture who was visiting the farm, on seeing it, remarked : "Oh ! I see ! A steam plough !"

Until Mr. Robertson arrived, the trials of implements, etc., were not at all systematic. Neither in those days nor for long after was any real attempt made to test indigenous implements thoroughly. Soon after his arrival the farm had begun to manufacture implements, etc., and a number of implements and tools had been sold in various parts of the Presidency. At the same time, a special grant was made to enable the Superintendent to import implements and machines from abroad to meet local demands. Mr. Robertson then reported that "we have now facilities to experiment with a view to determine the shape and description of implements best suited to the circumstances of the Indian ryot and last but not least, we can prove to the Indian cultivator that his local smith and carpenter can make up and repair any of our most useful implements." The implement to which special attention was given was the plough, and a form was evolved which had considerable advantages. At the same time, a leaning towards American styles became general and imports from that country were frequent, especially of chaff-cutters and maize-hullers. Of these machines, as well as of a number of waterlifts, including a bucket-pump driven by a steam engine, trials were recorded in 1870, and it was then that the Double-Mhote, to which Mr. Robertson became greatly devoted, was first mentioned, and the data then recorded as to the cost of lifting water, though slightly modified by him in respect of the Double-Mhote, remained those of reference on the subject until Mr. Chatterton's trials* of 25 years later. Speaking generally, it was to waterlifts and especially ploughs that attention was thereafter directed at Saidapeth, but notwithstanding the many advantages of ploughs of European type, they have not still come into general use. In later years several

* *Vide* Bulletin No. 32 of the Madras Agricultural Department, dated 1905-06.

private firms spent considerable sums in endeavours to push the trade in such ploughs. There is, however, one exception to this and that is the introduction from Saidapeth in the late seventies, largely owing to the efforts of the late Sabapathy Moodelliar, of the heavy iron ploughs now so generally used in the Bellary and Anantapur Districts for breaking up black cotton soil which is infested with the grass *kundara nattu* (*Ischæmum pilosum*)*.

But it is not necessary to follow the work done at Saidapeth in respect of implements and machinery further, and I may turn to other matters that early received attention. In the first report there is mention of trials of Lucerne, of which the Committee was not hopeful; of guinea grass, of which it is said that it "is very hardy, easily cultivated and propagated, and yields frequent cuttings"—an opinion amply justified by later experience; of Chinese sugarcane, with which not much success was then attained: and of English clover, with which there was such success that the Committee proposed to get more seed and the seed of Italian rye grass also. In the next year, there were trials of several kinds of exotic tobacco, which were said to have grown well but of which I have not been able to find any further record; of "French honey-suckle" and Maltese Lucerne, which both apparently failed; and of the Carob bean, some trees of which I can remember as still standing and bearing small thin pods ten years later. The year 1867-68 was notable for several "unauthorised" experiments by the Superintendent amongst which were the sowing of wheat and field peas and also for the commencement of growing maize which later became a regular crop on the farm; whilst in this year a field was laid down in grass with Hariali (*Cynodon dactylon*). During these years the chief native crops grown were sorghum and horse-gram (*Dolichos biflorus*), and with these fair success was attained. In 1869-70 attention, so far as crops are concerned, was directed to these last two crops with special reference to their use as

* Ploughs for the same work have only recently been adopted in Dharwar. *Vide* Lecture by Mr. H. S. Lawrence before the Royal Society of Arts, January 1908. Dharwar adjoins Bellary on the west.

fodder crops, and special papers were prepared and published by the then Superintendent on these matters, as well as another on the growth of Carolina paddy. Maize continued to demand attention, and the reports show that Italian rye grass, German beet-root and mangel-wurzel were grown –but condemned ; it is also worth noting that Mr. Robertson alludes, amongst other crops which he tried for fodder, to the wild indigo (*Tephrosia purpurea*) of which he remarked that the sheep were very fond and said that he had selected some seed from wild plants, "and hoped that by cultivation after two or three generations, it will become a useful plant."

It was also about this time that attention was first given to the raising of fodder crops, and this was a necessity from the fact that a considerable flock of sheep was maintained on the farm. It had been started at the opening of the farm, on a basis of Coimbatore and Salem ewes which were crossed with a half-bred Coimbatore-Merino ram, whilst at the same date two Southdown rams were purchased in England, only one of which reached Madras alive. In the next year, Mysore sheep were added to the flock, and some Patna rams were obtained and used, but in 1869, Mr. Robertson pointed out that the flock, although His Excellency the Governor allowed free grazing in his park at Guindy, was far too large, and contained only a comparatively small proportion of sheep that were worth keeping. He then began a system of breeding after selection. In the previous year, some attention was given to the fattening of sheep, and in 1869 several experiments in this line were begun ; whilst in 1869-70 there were experiments in feeding cattle also. Pigs had been kept from the first, and though the Committee at one time doubted the advisability of continuing to breed them, they afterwards changed their minds and increased the stock with a view to the sale of sucking pigs and young porkers. Rabbits and poultry were also kept, and of the latter for many years there were continual new importations of good stock from Australia and England. Much of this work was altogether beside the question and was only rendered possible

by the peculiar situation of Saidapeth close to a large town like Madras; but the experiments in feeding cattle, though primarily intended to test the fattening value of fodders, etc., are of some interest, as they are, I believe, the only tests that have been made in India of the feeding value of local produce.

It should be mentioned also that at a very early date the feasibility and utility of the "box system" of housing cattle was clearly demonstrated there and, as Mr. Robertson remarked in 1870, "there can be no reason why working and young cattle should not be kept in loose boxes at night, and there is no better or more economical way of making manure than under the loose box system. On sanitary grounds alone, the system is worth general adoption." Further experience has only confirmed the justness of these conclusions.

In 1871 a new departure was made by dissolving the Committee. In submitting the last report its President, Mr. (afterwards Sir William) Robinson, whose influence in later developments was very great, fully reviewed the work in a letter worthy of study. From this time onwards the work of the farm was greatly concerned with implements, especially ploughs and with fodder crops.

When the scheme for district farms was formulated by Government in 1871, the primary difficulty was the provision of competent Superintendents, and a class of apprentices was formed to supply these. For training such men the Agricultural College was eventually established on the Saidapeth Farm. Meanwhile the Superintendent was provided with two Assistants. Of the latter I was one, and the other was recruited direct from Germany by Sir William Robinson. We were intended to relieve Mr. Robertson at head-quarters, but before this was possible the Agricultural College had commenced work in October 1876. The scheme of training was far too complicated and elaborate, whilst no proper provision was made for the teaching staff—though Mr. Robertson proposed the appointment to the staff of an Agricultural Chemist, a Botanist and a Veterinary Surgeon, both for scientific investigation and for professorial

duties—the idea being that instruction in veterinary science should be given at the College. And though the idea under which the College was started was undoubtedly correct—it is now being given effect to in all Provinces—the fact that provision for experimental enquiry in all parts of the country dropped largely out of sight was, perhaps, the real cause of the failure of the institution.

A few years later, there came the establishment of the Agricultural Departments (or Land Records Departments), and there Mr. Robertson was not provided with a post. The College was handed over to the Educational Department, and the farm was for a short time retained under the Agricultural Department as a temporary seed and cattle depôt. In 1885 the latter connection was finally broken up, and about half the old farm estate was attached to the College for teaching purposes, and the remainder was distributed for various public purposes.

With the history of Saidapeth for the last 25 years I have had no intimate connection, but I have tried to give here a sketch of what was done in connection with what was one of the earliest, if not absolutely the earliest, persistent efforts made in India towards the development of a sound method or policy in the matter of agricultural improvement and to which effort may easily be traced much of recent development in that direction. I think that it will be admitted that on the whole the Saidapeth Farm did useful work as the pioneer of agricultural work which we all hope will now be more persistent.

THE EXTENSION OF CULTIVATION OF FIBRE PLANTS IN INDIA.

THE following is a report drawn up by a Committee consisting of Messrs. Gammie, Burkill, Finlow, Clouston and Subba Rao, for the information of the Board of Agriculture. It was prepared in 1908, laid before the Board for criticism and subsequently slightly amplified by the Committee, on information obtained by the Inspector-General of Agriculture from the Directors of Agriculture of the various provinces :—

The Committee limited consideration to particular crops :

(1) Ryots' crops—Jute, *Hibiscus cannabinus*, *Crotalaria juncea* and Cocoanut.

(2) Capitalists' crops—Rhea, Agave, Pine-apple, Sansevieria and Flax.

(3) Fibres worth experimental attention, *e.g.*, Plantain, Malachra and Sida.

Jute.—At present the cultivation of jute is practically confined to Bengal and Eastern Bengal and Assam. In both of these Provinces, it is one of the most important crops, and its cultivation increased rapidly, owing to high prices until 1907. During the last two years, however, there has been a diminution of between 30 per cent. and 40 per cent. in the area under jute, caused, partly by low prices, due to bad trade and to overproduction, and partly, by the great rise in the price of rice produced by famine conditions in Bengal and in other parts of India. While there is little doubt that, in some districts, jute has replaced rice to a certain extent, the ryots who grow jute now generally know that paddy or a rabi crop can usually be grown in the same field in the same year. This should be considered by those who think that the extension of the

cultivation of jute would seriously interfere with the food-supply of the country, for, on the other hand, the little diminution in outturn of rice caused by increase of jute is more than compensated by the enhanced buying capacity of the country on the return of the more profitable crop. The cultivation of jute is extending in Assam and is very profitable there, where large areas of virgin land are available for the crop. Its cultivation increased rapidly in Behar during the years 1904-1907 when prices were high ; but latterly the area has decreased to about one-third. Its place in the crop rotations of this tract is still indefinite. During the last four years, trials with jute have been made in other parts of India. The results of the experiments indicate that jute might be grown in—

(*a*) The Deltas of the Godavari and Kistna, Madras (with irrigation).

(*b*) The Malabar Coast, Madras.

(*c*) The Chhattisgarh and Nagpur Divisions of the Central Provinces (with irrigation).

In the Madras Presidency, a number of private landowners are trying jute in small areas on the Malabar Coast districts. Experiments in the Kavery delta have been abandoned, as want of skill on the part of the cultivators and the remunerativeness of paddy augured no success. The same causes will probably hinder progress in the Godavari and Kistna deltas. In the Central Provinces, the crop will continue to be grown on demonstration plots. Its cultivation will probably be limited to tank-irrigated areas where it may possibly alternate with wheat, the latter being a dry rabi season second crop. In Bombay, the experiments were not successful, and the crop is not likely to be introduced on a large scale anywhere in the Presidency. It is not likely that Jute can be profitably grown in the irrigated districts of the Punjab, unless practical arrangements can be made for retting the crop. Artificial tanks filled from the canals would as a rule be required. In the United Provinces of Agra and Oudh there does not seem to be, at average prices, much room for this crop in the districts served by the canals, and if the crop is grown to any

extent, difficulties may arise, as in the Punjab, in making proper arrangements for retting. Jute has been successfully cultivated in the lands belonging to the Maubin Jail in the Irrawaddy Delta for a number of years; but although this success has been duly advertised and quantities of seed have, from time to time, been distributed to other parts of Burma, the experiments have failed to induce general cultivation. The crop has not become popular in Burma probably on account of the dearness of labour and the extra trouble involved in its cultivation as compared with paddy; but a number of private individuals have taken up jute cultivation in an experimental way. The suitability of the crop for Lower Burma will be particularly studied at the Hmawbi Agricultural Station, especially in regard to the right times of sowing, the varieties which can be most profitably grown and the possibility of growing rice and jute on the same land in the same year. It is believed that the development of jute cultivation, on any commercial scale, will depend on the erection of a Jute Mill in Rangoon or any other convenient centre, but the cost of labour in Burma, as compared with India, may form a serious commercial disadvantage.

Hibiscus cannabinus (Ambadi, Mestapat, Gogu, Sankukra).—This plant is cultivated in many parts of India as a mixed crop, but rarely as a pure crop excepting on the East Coast of Madras, and, to some extent, in the jute-growing districts of Bengal. It grows excellently on well-drained land in a wet climate, such as may be found in the jute districts; but it is capable also of thriving under conditions which would not suit jute without irrigation. In this last fact lies the importance of the plant. There is no advantage to be got by extending its cultivation where jute will easily thrive: but in regions of more moderate rainfall the cultivation of *Hibiscus cannabinus* might profitably be extended. In Madras, its cultivation is firmly established in Vizagapatam and Guntur, which include $\frac{9}{10}$ths of the total acreage of the crop in the Presidency (68,000 acres in 1906-07). In 1907-08, when the total acreage was 71,476, it was, in these two districts, 60,620 acres. It has been suggested that the quality of the fibre has deterior-

ated, but enquiries made on the spot in 1906 indicated that the alleged deterioration is due to fraudulent watering and to carelessness in preparation owing to high prices, rather than to any actual deterioration of the plant. Prices have recently been low. A mill for spinning this fibre and manufacturing it into gunnies has been worked for some years at Bimlipatam, which probably accounts for the considerable area under the crop in the Vizagapatam District. Another mill has recently been opened at Ellore in the Kistna District and may encourage extended cultivation. The total acreage under this crop in 1906-07 in the Bombay Presidency was said to be 145,623, but for 1907-08 only 97,821 acres are recorded. It is generally mixed with other *kharif* crops, and the fibre is used chiefly for well ropes and for other home purposes. In the Central Provinces, it is grown in mixed crops. Its fibre is considered inferior to that of *Sann* (*Crotalaria juncea*) ; the general opinion being that *Sann* gives a better outturn of fibre and a greater profit per acre when each crop is planted alone. The extent to which *Hibiscus cannabinus* is grown as a mixture with other crops in the United Provinces is not known. It is usually grown as a border crop, and calculations regarding areas and outturn are very uncertain. The fibre obtained in the east of the United Provinces is perhaps of better quality than that grown in the west. It occupies in the Punjab an insignificant area. It is frequently grown as a border crop round sugarcane, cotton and maize, as a protection against straying cattle. It is never grown in separate plots. The produce is chiefly used locally. It is cultivated, to some extent, throughout Upper Burma ; but it is not likely, in the near future, to have any particular commercial importance. The total area is at present about 10,000 acres.

Crotalaria juncea.—The fibre of this crop does not compete with jute as does that of *Hibiscus cannabinus* : but in market value it is superior to both. Sann-hemp can best be grown in districts of moderate rainfall, and, therefore, does not compete with rice. It is, in some parts of India, frequently grown as a green manure crop before rice, and in others as a second crop in the same year after early rice for fibre. This rotation is advantageous.

because *Sann* is a leguminous crop. The total acreage under the crop in the Bombay Presidency in 1906-07 was 23,700 acres and in 1907-08, 25,470 acres. It is chiefly grown as a *kharif* crop for fibre, but also to a considerable extent as a green manure crop. In the Thana District, it is grown as *rabi* crop, in succession to early rice, for fibre, which is used by fishermen in making twine for nets. The returns for Madras give a total of over 300,000 acres: but it is known that only a very small proportion of this—less than 20,000 acres—is grown for fibre. It is most extensively cultivated for fibre in the Northern Circars, chiefly in the Amalapuram and Narsapur Taluks of the Godavari and Kistna Districts. In the rest of the Presidency, with the exception of the Tinnevelly District, where some fibre is manufactured into extremely durable gunny bags, the cultivation of the crop is confined to the production of fodder. In Eastern Bengal and Assam this crop is largely grown in the Serajganj sub-division of the district of Pabna, where the estimated area is 33,900 acres and where it is generally grown, in the cold weather, on land which bears a jute crop in the same year. The area in Chittagong, where it is also grown as a *rabi* crop decreased from 7,900 acres in 1906-07 to 1,600 acres in 1907-08. The total estimated area in Eastern Bengal and Assam is about 42,000 acres and the estimated export of the fibre is 30,000 maunds. In Eastern Bengal jute is much more important, but it is possible that the cultivation of Sann-hemp can be somewhat extended with profit, though as the water-supply for retting is limited in February and March, the months of its cutting, this would only be along the banks of rivers. In the Serajganj sub-division it is only grown for fibre quite close to water.

A note by Mr. Clouston, the Deputy Director of Agriculture in the Central Provinces, on the cultivation of fibre plants in the Central Provinces was published in the *Agricultural Journal of India* (April 1908). The total area under *Sann* in the Central Provinces was 55,400 acres in 1907 which increased in 1908 to 85,044 acres. In Berar the acreage was 32,360 in 1907 and 35,484 in 1908. It is always grown as a pure crop and is cultivated for

its fibre chiefly; but the seed is a valued cattle food. It is generally believed that only one variety of *Sann* is grown throughout the Central Provinces and Berar. Retting costs a good deal and a suitable cheap machine to extract the fibre might be advantageous in extending the cultivation. The area in the Central Provinces has nearly doubled during the last ten years, where *Sann* cultivation is so profitable that the crop has been largely substituted for wheat. The cultivators understand that this crop is a hardy one and improves the condition of the land. It is grown to a small extent as a green manure crop, particularly for irrigated wheat and sugarcane. In the cotton tracts no extension of this crop can be expected, as cotton pays better. In the rice tracts, *Sann* could probably be profitably grown on much of the land which is planted with other second crops. The total quantity of Sann-hemp exported from the Province and the value of the same from 1904 to 1906 are shown below :—

Year.	Maunds.	Value.
		Rs.
1904-05	226,751	12,18,783
1905-06	201,402	10,82,534
1906-07	168,096	9,03,513
1907-08	271,727	14,60,582

In the Punjab there were 57,000 acres under Sann-hemp in 1906 and 52,400 acres in 1908. The sub-montane tracts showed the greatest area, very little being grown in the south-west of the Province. Throughout the Punjab, the crop is usually sown in very small plots, and very little is marketed. The crop is sown almost solely for fibre, but in the Hoshiarpur District, it is estimated that 1-10th of the crop was grown for green manuring. The practice of green manuring with *Sann* is rare at present. The retting and cleaning of the fibre are regarded as being tedious and expensive, and Sann is consequently considered to be less remunerative than some other crops. The imports of Sann-hemp fibre into the Punjab in 1906-07 were 15,382 maunds and in 1907-08 20,984 maunds, almost entirely from the United Provinces. The exports amounted to only 4,078 maunds in 1906-07 and 2,584 maunds in 1907-08.

The returns of the United Provinces show an area in 1906-07 of 133,000 acres of hemp, which include both *Hibiscus cannabinus* and Sann-hemp: and in 1907-08 of 158,000 acres. Practically the whole of this area is devoted to Sann-hemp, which is grown for fibre and almost universally also as a border crop with *kharif* crops. Part of the produce is worked up by cultivators into ropes for home use; but the export is considerable. The trade returns of the United Provinces for 1906-07 show practically no imports of hemp, but exports aggregating 400,000 maunds valued at 22 lakhs of rupees and in 1907-08 of 409,800 maunds, valued at Rs 26,17,000: most of this is Sann-hemp. There is a steady trade with Calcutta and a very fluctuating trade with Bombay. The crop is a well recognized feature of the local agriculture, and the trade in fibre is an organized one. The area generally responds to the prices offered.

The crop does well in the Tavoy District of Tenasserim, where it is grown there after paddy. The estimated area is about 400 acres in Lower Burma, when the fibre is used for fishing nets. It is very doubtful whether there will be any great development of Sann in Burma unless the Department of Agriculture succeeds in introducing it for green manuring.

Cocoanut Fibre.—The cocoanut palm is grown in all the Coast districts of India, but to the largest extent, in the southern portion of the Bombay Presidency and in Madras. In the Malabar Coast districts, the coir industry is a very large one, amounting to many lakhs of rupees per annum. Although this palm takes time to mature, its cultivation is popular, because it supplies food as well as fibre for many years after it has reached the fruiting stage. In Bengal it is plentiful in the lower Gangetic basin; but it exists practically only in garden cultivation; there are no large plantations. The cocoanut palm is grown on a large scale in Bakarganj and Noakhali in Eastern Bengal and Assam, but the fibre is never extracted. There seems no reason why this industry might not be introduced with profit into the Province.

Little, if any, attention has in the past been devoted to the fibre of the cocoanut in Burma, except in the jails. Even for food purposes cocoanuts have to be imported largely. The cultivation of the palm for fruit and fibre has been taken up in Akyab by one European. If he succeeds, his experience may attract attention to this crop. There is a coir factory in Rangoon, and the collecting of coir for it would seem deserving of encouragement. The want of sufficient cooly labour in Moulmein and other centres, makes it impossible to start coir factories in them. The total area under this crop was returned as 13,590 acres in 1906-07, and 13,070 acres in 1907-08.

Plantain fibre.—There are possibilities of a useful industry in plantain fibre. In many parts of India the plantain is common in every garden; and in Bengal, Assam, the Bombay and Malabar Coasts, the Delta tracts of Madras and in parts of Burma, whole groves of plantains are quite common. The fibre of the plant which produces good fruit in India is usually, however, far inferior to that of *Musa textilis*—also a plantain—which is the source of Manilla Hemp. Moreover, the amount of fibre obtainable from a plantain in India is very small. Experiments have shown that the fibre can be extracted by a simple hand machine; but in view of the low market price obtainable—as a rule, not much more than half that of Manilla Hemp—it remains to be proved that a plantain fibre industry in India is a commercial possibility. The fibre is of little use for the manufacture of cordage as its strength is below the standard usually demanded for rope-making. There are about 124,000 acres under plantains in Burma, but nothing is done with the fibre. The crop might give paying results for fibre after producing fruit.

Sida.—Species of Sida are quite common jungle plants in most parts of India: but in order to attain the length necessary for a fibre plant the crop must be grown on well-drained land, either in a moist climate or under irrigation. Experiments under these conditions have given promising results. It is, however, necessary to overcome certain difficulties before recommending the crop for general cultivation.

Agave and Rhea.—For the purpose of this note, Agave and Rhea may be taken together. The conditions of soil and climate suitable for these crops are now fairly definitely known. It used to be thought that Agave would grow and thrive on any soil and under any conditions of climate. It has, indeed, been stated that the poorer the land, the better Agave will thrive: but experience indicates that both Agave and Rhea require good land for rapid growth. For the latter also fairly heavy rainfall is required. Although it is possible to extract both Agave and Rhea fibre by hand, the products obtained are usually inferior to those obtained by machinery. Therefore possibly the cultivation of these plants should, for some time, be continued by capitalists who can afford to pay for expensive fibre extractors. Rhea has been extensively cultivated on the estates of Indigo Planters in Behar, but has not proved a profitable crop. Both Agave and Rhea require some years' growth before they give any considerable yield of fibre, a fact which discourages the ordinary ryot from attempting their cultivation.

The results of the recent experiments at Dalsing Sarai and elsewhere have been set forth excellently by Mr. B. Coventry in the *Agricultural Journal of India*, 1907, pages 1-14: they practically proved that the climate of Behar, with a rainfall of 45 inches, is too dry to admit of a sufficient number of cuttings being made per annum to make rhea pay. This crop thrives in the moist climate of Assam, where it is possible to obtain five cuttings per annum and where, to a small extent, it is a ryots' crop. In Madras, rhea is grown on a small scale in the Shevaroys. The Glenrock Company opened a rhea plantation near Metupalayam in the Coimbatore District 25 years ago, but did not make a profit out of the cultivation.

In Bombay where rhea has been under experimental trial for many years, further recent experiments with it at the Ganeshkhind Gardens, Kirkee, have confirmed the conclusion that the soil and climate of the Deccan are unsuitable for the plant. It is said that in Lower Burma, a variety of rhea grows wild on the banks of streams in the Tharrawady District, along the

foot of the Pegu Yoma range, and that the fibre is used to make twine for fishing lines. Experimental plantations of *B. nivea* and *B. tenacissima* have been started by the Forest Officer in Tharrawady, who reports that the latter species is growing with success. Rhea grows wild both in the Northern and Southern Shan States. The fibre is chiefly used for making paper, but is also made into cloth and strong twine for fishing lines, etc. Two varieties of the plant are known, one being considered better than the other for the above purposes.

Varieties of Agave are to be found in most parts of India under widely different conditions of climate and soil; but Sisal Hemp (*Agave sisalana*) is the only variety with which systematic attempts at cultivation have been made excepting by the prison authorities. Sisal Hemp yields the largest and quickest returns under careful cultivation on good land in a moist climate; but only one plantation (Dauracherra Fibre Company, Sylhet, Assam) has existed long enough to yield definite results, and these do not prove that Agave cultivation in Assam is certain to be a profitable industry. A few plantations of Agave exist in the United Provinces, but have hardly reached the cutting stage. The raw material which is at present dealt with is chiefly obtained from railway fences taken on lease. The only place in the Madras Presidency where Agave fibre has been extracted on a commercial scale is in the Coimbatore District from the plants growing along the railway lines. This species proves to be *Agave cantala*. Several European planters are trying Sisal in the planting districts, and the Madras Fibre Company has some plantations in the Anantpur and Chingleput Districts. The cultivation of Agave is not likely to be taken up in the near future by ordinary ryots. The extraction of the fibre by hand is unpleasant on account of skin irritation caused by the sap. The chief purpose of the Hindupur Government plantation is to grow Agave experimentally on land where the rainfall is too precarious for other crops. It is also intended to supply Sisal plants to those who are interested

in the cultivation of this plant. Agave has been but little exploited in the Central Provinces, and the cultivation is not likely to become popular. The common species there is *Agave cantala*. It is usually grown in hedges, around groves and gardens, but nowhere in abundance. Fibre is not extracted from it extensively. In the Kawardha Feudatory State adjoining Bilaspur, its cultivation is fairly large and the fibre is used in making ropes and cloth. The labour involved in extracting the fibre is considered both hard and degrading, while the juice of leaves produces eczema on the legs and arms of the labourers. Agave cultivation has been extended of late at the jails in the Central Provinces, and the Inspector-General of Prisons had 87,459 aloes planted out last year in his various gardens. At these jails, all the work of cultivation, of extracting the fibre and of making it into ropes, rugs, etc., is done by the prisoners. This industry engages labour at all times of the year. On the *bhata* plains of Chhattisgarh where there are very large areas of waste land, it may be possible to start aloe plantations: but if this is to be done successfully, the work will have to be undertaken by an enterprising firm with sufficient capital and practical knowledge. It has yet to be proved that the aloe can be profitably grown for commercial purposes on such soils without irrigation. Experimental trials are being made. So far as is known, the *Agave vera-cruz* is the only Agave found in Burma. It is not systematically cultivated for its fibre, though it is used in some prisons for rope-making. It is not yet certain whether Agave would repay cultivation, and in any case a better species than *A. vera-cruz* should be grown.

Fibre from pine-apple and Sansevieria.—The extraction of fibre from pine-apple is not likely to become an extensive enterprise in any part of India. Sansevieria has been repeatedly tried by planters in Assam, but without paying results. It is possible that fibre can be profitably obtained from the pine-apple in Southern India.

Flax.—Flax as a fibre crop is not yet produced on a commercial scale in India; but extensive experiments were

begun in Bengal about four years ago and are still in progress. They will, when complete, probably indicate that fibre of good quality can be profitably produced from this crop in several parts of India. There are large areas under linseed in the different Provinces, and in some places where the conditions are specially favourable, it may be possible to produce good fibre as well as seed. In other tracts the coarse stem of the country linseed may yield fibre which is inferior but still worth extracting. Experiments are, however, required to determine this, and also to show how such fibre can best be utilised. Flax cultivation has no particular prospect of success in the United Provinces, except perhaps in a few favoured localities; unless the growers can afford to stack their straw until clean water is available. Except on the Dharwar Farm, the different varieties of imported flax have not yet been found suitable for cultivation in the Bombay Presidency. It has, so far, not succeeded in Burma, but no very systematic experiments have yet been made. In the Punjab, 39,874 acres of linseed were sown in 1906-07, 14,669 acres being in the Kangra District and most of the balance in the sub-montane districts; but in 1907-08 only 29,348 acres were sown. The crop is grown for seed. It is thought that good material for fibre has been obtained from trials made with Russian linseed; but the difficulty lies in the retting, which is being studied at Lyallpur as well as at Pusa and at Dooriah in Behar. Experiments in the Punjab which were conducted many years ago were well reported on as regards the growth of the plant; but the retting question was not then fully examined. The local variety of the Punjab is not suitable for fibre purposes, owing to its established habit of short and bushy growth.

Malachra capitata.—The Bengal Agricultural Department tried *Malachra capitata* at Cuttack, but gave it up as hopeless after two years' trial. Similarly, experiments conducted at the Rajshahi Experiment Station in Eastern Bengal and Assam, indicated that its cultivation is not likely to be profitable. Experiments have not yet been made in other provinces.

General conclusion.—The Committee believes that it is possible to extend largely and profitably in the immediate future, the cultivation of Jute, Sann-hemp and *Hibiscus cannabinus*, and that later on, it is possible that a portion of the linseed grown over large areas in various parts of India may be utilized for the production of fibre as well as seed. A considerable increase of Agave cultivation is possible in Assam and in tracts which have similar physical and climatic conditions. Successful rhea cultivation must apparently be limited to a comparatively narrow zone where both climate and soil are particularly suitable. The Committee affirms that jute is a very paying crop and believes that it can usually be followed by a food crop in the same year.

The Committee lays great stress on so arranging the rotation of food and fibre crops, that the encouragement of the latter shall not be at the expense of the former. From this point of view, those fibre crops, which occupy the ground for one season only, are preferable to those of a perennial nature.

The Committee believes that the demand for fibres is bound to increase, as they are essential for nearly all branches of trade: also that it is not likely that prices will fall so low as to render fibre cultivation in India unremunerative.

LUCERNE DODDER.

By G. B. PATWARDHAN, B.Sc.,

Asst. Economic Botanist, Bombay.

In April of this year samples of lucerne infected by Dodder were received from Boisar in the district of North Thana, Bombay Presidency. I was deputed to examine and report on the pest, and the following are observations made on the spot and remedies suggested.

The parasite is known in Thana as *Vinoli* and round Poona as *Ambarvel*. Botanically it is *Cuscuta chinensis* and has the usual well-known habits of this genus. The seeds are small, brown, not more than a millimetre in largest diameter. On germinating, the seedling attaches itself by a delicate filament to the lucerne stem, then loses hold of the ground, and from that time onwards lives entirely on the lucerne which it penetrates by numerous suckers and thus robs it of its sap. It develops into a tangled mass of yellow filaments spreading all over the host plants and may finally kill them. The Dodder produces numerous tiny white waxy flowers which finally give the seeds.

The attachment of the suckers is so complete that one cannot take away a single thread without breaking it or peeling it at these points and also damaging the lucerne. So an attempt to relieve the plant from the ravages of the parasite by uncoiling the threads is bound to end in failure.

The Cuscuta is known to the people of the following towns and villages as occurring in lucerne fields :—

Kurgaon.	Goregaon.	Dholwar.
Boisar.	Umbergaon.	Koledi.
Sanjan.	Pasthal.	Nasik.
Bordi.	Godhadi	Poona.
Tarapur.	Parnuli.	

It seems to increase with the number of cuttings of the lucerne. A field of lucerne reserved for seed is not so completely robbed of its nutriment as to kill it before seeding. The chances of increase of the pest are reduced as no cuttings are taken from such a field. Sometimes one or two cuttings are taken before it is left to seed. In both cases the host and the pest come to maturity in May and seed together then. The separate collection of the lucerne seed becomes a very difficult work as the fruit bearing threads are sometimes found coiling in the grooves of the twisted lucerne pod and both have unavoidably to be picked together. Consequently the seed becomes mixed with that of lucerne and is sown again the following year.

Knowledge of the Plant as a Pest.—It is not generally recognised in these villages as a serious pest. It often occurs in stray corners of a field damaging a few plants only, and so is not so much noticed. The weed is recognised by some as having existed these four or five years and increasing from year to year so much that the fields on the Kurgaon farms were completely destroyed. So it will be noticed that its destructive nature will be apparent when too late unless early precaution is taken; as a rule, whole fields were not seen to be affected. In some it occurred in small patches here and there in the middle of the field, while in other cases larger areas were also affected,—one field might be attacked and its neighbouring unattacked. In another place in the same village the pest was not seen in any field. So it is extremely local in distribution.

Extent of the affected area.—From the above it is obvious that the affected area cannot be estimated in acres, nor has the pest yet caused general damage so as to cause universal anxiety. In a few cases only has the pest been so bad as to attract notice.

The present knowledge of the people regarding the plant growing on lucerne can be summarised as follows :—

(1) Some have simply observed the fact of its existence as a foreign plant growing on lucerne without any idea of its possibility of causing any damage.

(2) Some have noticed its character as a pest, but have looked at its existence without interest as causing too little damage to take note of.

(3) Others have been apparently anxious about the strangeness of the thing, but have made no further inquiries.

(4) One or two have really suffered from the rapid extension of it in their fields and are seriously anxious about eradicating it.

(5) Few know that it flowers and seeds at all.

(6) None know that it must have originated by accidental mixture of its seeds with those of lucerne.

(7) The seed of the pest is scarcely seen by anybody, nor can anyone separate them from the mixture.

Sources of Infection of the Fields and Remedies :—(1) The seed is undoubtedly brought in with that of lucerne. An examination of seed obtained from a gentleman at Sanjan proved this. Another gentleman got the seed for the present crop from the same place and had his crop very badly affected. This year he made previous inquiry of the vendor, whether or not the latter's fields had *Nimoli* and bought his seeds on being assured of its absence. This seed was examined and was found to be quite free from Dodder. So, if seed is purchased, a guarantee of freedom from seeds of the parasite should be obtained before such a purchase ; or if such guarantee is unobtainable, the Dodder seed should be sifted or picked out before sowing. At the time of sowing seed extreme care is necessary to collect the true lucerne seed only.

(2) If the pest has advanced too far, the whole field should be burned.

(3) If the weed has not flowered, it should be ploughed in and the land should remain exposed to the sun during the hot weather.

(4) The seed of the *Cuscuta* derived from plants growing on neighbouring trees and hedges may be blown by the wind. This seed will germinate and grow upon the crop. *Remedy.*—Every trace of it on neighbouring hedges and trees should be destroyed

Other plants observed to be affected are :—

Euphorbia neriifolia	...	...
Bridelia retusa	...	... Asan
Terminalia tomentosa	...	... Ain.
Acacia arabica	...	... Babul.
Eugenia jambolana	...	... Jambul.
Solanum melongena	...	... Wangi
Andropogon annulatus	...	... Gavat

Caution.—If the purchaser is not able for himself to distinguish Dodder seed in lucerne, he should, before purchasing seed for next year's planting, send samples of seed to the Agricultural Department for examination.

CULTIVATION OF TEA IN THE KACHIN HILL TRACTS OF KATHA, BURMA.

By C. K. DAVIS,

Civil Officer, Kachin Hill Tracts, Burma.

Kachins are great tea imbibers, and it was not surprising to find in the course of my recent tour in the Kachin Hills of the Katha District that almost every village tract boasted of a number of trees varying from 60 to 6,000. The plant is probably the same variety which occurs wild in some parts of Burma.

The gardens which exist have not been laid out on any system and small patches of from 20 to 60 trees may be encountered in the thick of the jungle, each with its owner. The gardens or claims are not fenced. Each man knows the number of trees he owns. All the care the owner bestows on his claim is to clean the undergrowth, leaving only the young tea plants that have grown of themselves from seeds shed. Too great care, it is said, will kill the trees. No kind of manure is ever used. Efforts to sow seeds are only successful in a measure and things are left very much to Nature. An enterprising Shan of Thayagon, a village at the foot of the hills in the Mawlu Township, has year in year out, failed to grow from seed or transplant young trees to his village. He has now discovered that tenderness and care are wasted on the seed, a handful of which, if thrown into a clump of plantain, gives excellent results. The seeds germinate readily and displace the plantain which is cut away. It is noticeable, however, that the tea gardens are only found where the water easily drains away and there is much shade.

The following method is adopted by the Kachins in raising plants from seed. Seed collected is sown just before the rains commence in circular beds of two feet diameter. The earth is

dug up a span or two and in the deeper holes stones are placed at the bottom. The seeds are then thrown in and covered over with the earth which has been excavated. Dried leaves are sometimes thrown in. No further attention is paid. At the beginning of the following rains the seedlings have attained a height of from 6 to 10 inches. They are then transplanted. Fair-sized stakes are fixed to the earth to mark the locality of the little plants and to protect them from being trampled on by cattle. In some cases the seedlings are not transplanted till they are two years old.

Like teak seeds, tea seeds are said to come up spontaneously after a clearing has been fired. Seeds that have been scattered by Nature and buried under dried leaves and twigs have then a chance of springing up. In many places lands devoted to taungya or shifting cultivation have developed into tea plantations.

Three years after transplanting, the Kachin nips off the tops of the young plants by way of pruning them. The following year they are ready to be picked. Frequent picking without pruning gives a fair yield and the Kachin is satisfied.

The tender leaves are first picked in the month of April and they are ready to be picked again every alternate month up to August. The April pickings are the best and later pickings have not the same market value and fall as much as one half in price. What is picked is either boiled or broiled according as wet or dry tea is required. What is boiled is squeezed with the hand on cooling to release the water and is packed in leaves in convenient packets for sale. It is sometimes put into big bamboos of one viss capacity which are plugged at the open end with bamboo leaves and buried two feet under ground. This keeps as long as two years. Wet tea sells at four annas a viss (3·60 lbs.) at Mohnyin on the line of railway.

The leaves that have been broiled are kept over the fire place in the house, and when enough has been collected, they are smashed with the hands and rammed into green bamboo tubes about 18 inches long and 1½ inches in diameter. The green bamboo, in the operation of filling, is placed over the fire or in

hot ash and what moisture is contained is absorbed by the dried leaves which in time form a hard cake in the bamboo. Such tubes contain from 25 to 40 ticals and sell at two annas and eight annas each. Dry tea is also sold loose at Rs. 4 a basket of four viss.

A plant is said to attain a girth of ten inches in ten years. There are trees with two feet girth, said to be 25 and 30 years old. The average yield of a plant is one viss of dry tea a year. The big trees yield according to Kachin methods as much as two viss.

Insect pests are not unknown on the Kachin Hills and their inability to guard against them is a source of great anxiety to the Kachins.

The Kachins do not pluck tea systematically or with a view to trade. During such time the women can spare from taungya work and household duties, they pick enough for home consumption and perhaps a little extra to buy salt and cotton yarn with. The tender leaves only shoot forth in taungya cutting time and the industry cannot receive attention even as a secondary occupation. The men find more profitable employment with the timber firms which pay them handsomely.

Tea is brewed by Kachins in a small bamboo which serves as kettle, tea-pot and tea cup. Water is boiled in the bamboo, caked tea is scraped into it and when the concoction has cooled a little, it is sipped and passed round.

Shans and Burmese who have acquired a taste for Kachin tea prefer it to imported brands. If taken up on a commercial basis, the cultivation of tea on the Kachin Hills would be profitable. At present the markets of Myitkyina and Katha districts could be confidently counted on. At Kongra (square No. 38 K) a man came to purchase bamboos of dried tea which he took away to sell at the Jade Mines in the Myitkyina District. He bought at three bamboos a rupee and expected to sell each at eight annas to a rupee.

There is some hope that the tea industry will be taken up in earnest by the hillmen. It is asserted that before the Kachins

took to working for a monthly wage much tea was exported from the Kongra and Lamai tracts on the Western Range and that to this day Kongra-Lamai tea is well known in the plains. A map of the Kachin Hills showing where tea is largely grown is attached (Plate XXXVI).

BETEL LEAF AT CHIKKODI, BELGAUM DISTRICT.

By R. S. HIREMATH, B.Ag.,

Special Travelling Inspector, Department of Agriculture, Bombay.

Distribution.—Betel leaf is cultivated at Chikkodi, Hire-Kodi, Nagral, Naiz, Shiraguppi, Yernal, Rampoor and Latti in Karwar, and Elakha of Kolhapur State. At Chikkodi and Hire-Kodi its cultivation has increased in the last ten years, bringing large profits to the cultivators.

Soil.—Reddish porous black soil is suitable for this crop. "Shedi soil" which is irrigated in the morning and gets fairly dry on the surface at sunset is also suitable. "Sanna Yeri" soil (fine black soil) is to be avoided as it produces inferior leaves. There the plantation does not thrive after three years. In sticky soil, the roots rot. Swampy lands are useless. Suitable soil manured with Sann (*Taq*) gives the best results.

Locality.—The crop requires protection from high winds by dense hedges chiefly of *Shevri* (*Sesbania aegyptiaca*) where there is no natural shelter.

Climate.—Warm and moist climate is suitable to the prolific growth of leaves. From "Ashad" to "Bhadrapad" (*i.e.*, from July to September) the plants throw broad leaves which generally become "Pacca Pans" (ripe yellow leaves).

Preparation of land.—The land is thoroughly ploughed in January and February four times, and manured with about 50 to 60 cart loads per acre. Harrowing is done first with eight bullocks and then with four bullocks till good tilth is secured.

Decomposed ash is a good manure; fresh ash should not be used.

Preparation of beds called "Chires."—Beds are usually made 6 to 7 feet long. On first cultivation beds are made 7 feet long to grow coils every year in January and February.

At first, rows are furrowed lengthwise by hand 6 feet apart.

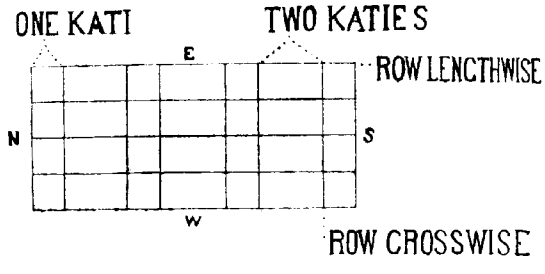

FIG. 1.

Then cross rows are made as shown in figure 1. The cross rows should be alternately one and two standard "Katis" (sticks) apart. They are made neat with an implement called "Madi-Gunti."

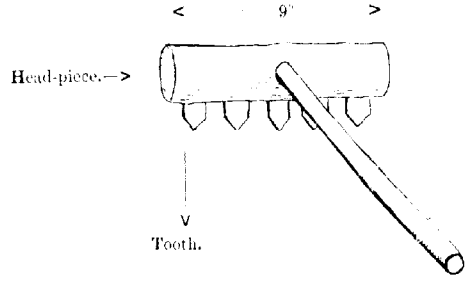

FIG. 2.

An area four "Katis" (24 feet) wide and 6 "Katis" (36 feet) long and containing 11 beds is known as a "Chire." In preparing it some portions of furrows are to be made level as shown in figure 3.

Each number shows a bed and the dots show the furrows undone. The unnumbered two beds are boundary beds called "Dandi-Sal-Madi"; compare this with Fig. 1.

A "Chire."

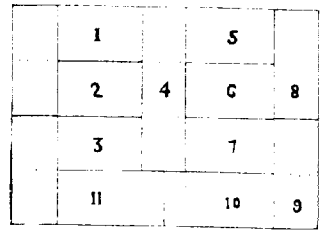

Fig. 3.

The following figure gives details* of a "Chire."

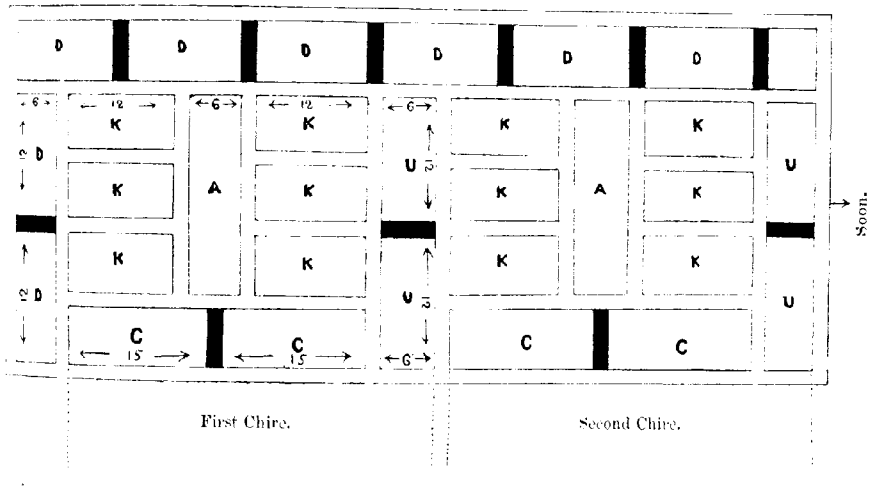

Fig. 4.

In the centre of each "Dandi-Sal-Madi" (bed on the boundary) plantains are planted.

Sixty "Chires" including "Dandi-Sal-Madi" form a betel-leaf garden. It can be watered by two men and two bullocks. The garden is divided into two portions of 30 "Chires" each

* In Fig. 4, the thick lines stand for ridges; double lines for furrows; D for "Dandi-Sal-Madi"; K for "Khurg" beds; A for "Ada-tang" beds; U for "Uchi-tang" beds; and C for "Chire-tang" beds.

with a path one "Kati" (6 feet) wide in the middle. Each portion usually consists of 5 × 6 "Chires."

A Betel-leaf Garden.

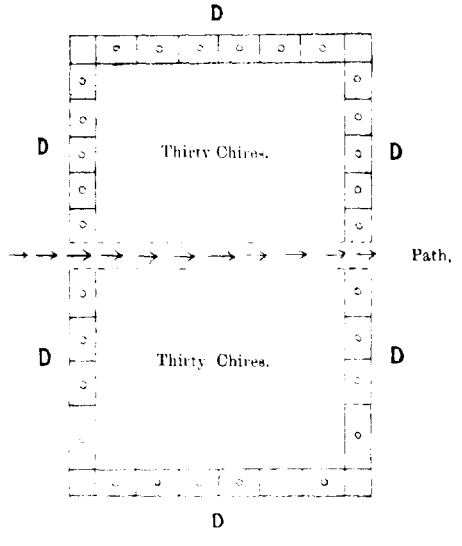

FIG. 5.

Usually an acre contains 50 "Chires."

Preliminary preparation for Shade and Support.—In "Jeshtha" (*i.e.*, June) *Shevari* seed (*Sesbania ægyptiaca*) is sown by hand thickly on both sides of a furrow. Besides this, "Nuggi (*Moringa pterygo sperma*), "Haliwala" (*Erythrina indica*) and "Chogachi" (*Sesbania grandiflora*) seeds are dibbled on the long sides of "Ada-Dangs," "Chira-tangs," "Khurgs," and "Ucha-tangs" in the proportion of five, four and three respectively. Usually "Haliwala" (*Erythrina indica*) is preferred for its lasting quality. It is irrigated when there is no rain after sowing. Maize seed is also sometimes sown as cobs can be taken before betel-leaf sets are planted.

Planting Sets.—In "Ashlesha" rain (*i.e.*, in August), shoots of betel leaf which bear many side roots are cut two feet long from some old plantation and planted lengthwise 11 in each

"Ada-Dang," 9 in each "Chira-tang," 8 in each "Ucha-tang," and 6 in each "Khurg." In all, 162 sets are required per "Chire" and 9,720 sets for a garden of 60 "Chires." A fresh stout and thick set gives a healthy creeper. Sets for seed should be planted within three days to ensure vigorous growth. Care should be taken to keep them thickly shaded and wet every second or third hour. Planting sets are put along the length, but not along the width, of beds. Furrows between the two "Ucha-tangs" and the two "Chira-tangs" are converted into ridges without sets.

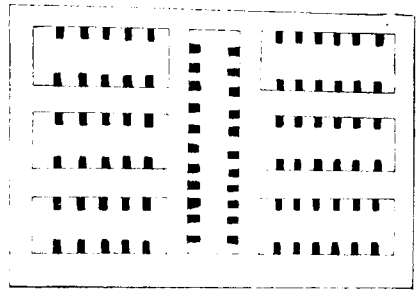

FIG. 6.

Each mark in each bed shows a pit for each set.

The "Kurpa" is used to make these long pits for the sets. The lower half of a set is put in this pit and the upper half remains above ground.

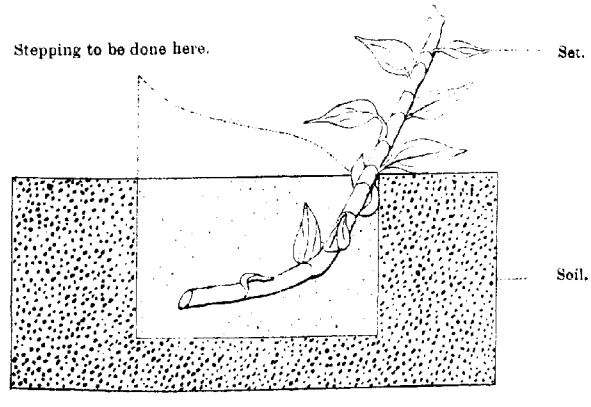

FIG. 7.

Level.—These pits are then filled with fine soil free from stones or gravel to enable the sets to strike roots. Leaves in the lower half of the set, if any, are made to cover the stalk before the fine earth is put in. A person then tramples on each cutting forcibly to make the earth solid. Water should be poured when pits are being trampled. But care should be taken not to allow water to stagnate in pits as toppings may rot.

Sets that have not taken root should be replaced by new ones. The sprouting sets are also protected from the sun by small branches of "Honnavari" (*Cassia auriculata*), planted in moist earth. This work is known as "*Hampu-Hacchana.*"

Watering.—Two bullocks and two men work 8 hours a day to irrigate a portion of 30 "Chires." Excess of water is harmful. During heavy rains excess of water is let out through channels of "Ucha-tangs."

Weeding.—Weeds should be removed as soon as they grow. They are taken out of beds by *Kurpa*. Those near creepers are uprooted by hand. In the hot season, "Kurpa" is used to preserve moisture but not in other seasons.

Topping and cutting roots of shade trees.—In January, Shevary plants (*Sesbania ægyptiaca*) about 6 feet to 7½ feet high are topped to shade the ground thickly for hot season.

In February side roots of all shade trees towards the sets are cut and earth is raised to avoid their injuring the growth of creepers.

Binding.—After some growth betel-leaf creepers are tied to their shade plants with leaves of "Apu" (*Typha augustata*) or "Jeku" (*Cyperus rotundus*) grass.

Lowering.—Every year from "Pushya" to "Magha," (*i.e.*, from January to February) creepers are lowered, coiled and buried in pits. Side roots of shade trees, if found in making pits, should be cut and betel-vine roots preserved. In lowering, creepers should not be twisted or bruised; the ties should be cut carefully. The bruised part should always be kept above the soil and should not be watered to avoid rotting. In burying, the coils should be made in the form as shown in figure 8 and the tops of all the off-shoots should be carefully brought to air.

Vertical Section of a Bed in which a coil is buried.

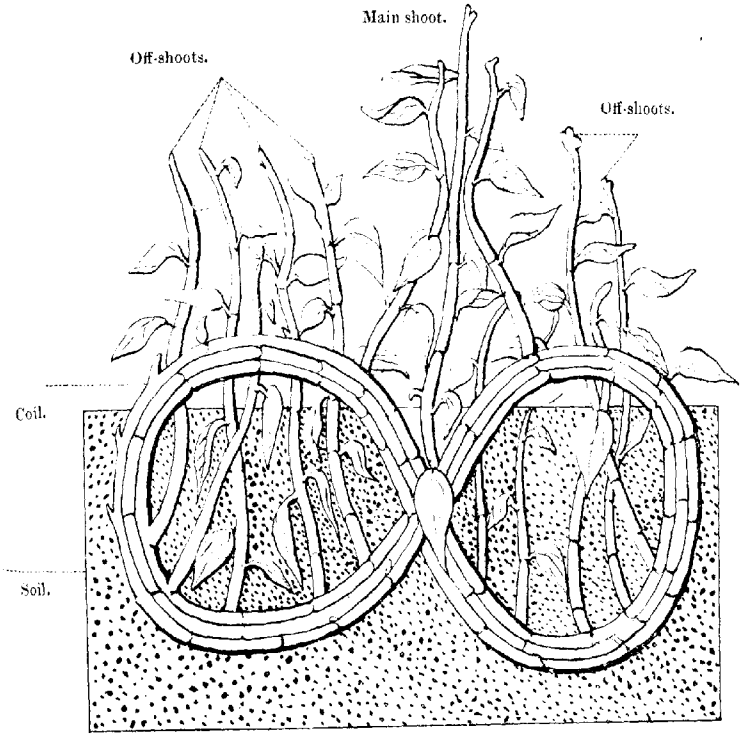

FIG. 8.

Every year the coils of each side of a bed approach one another.

Horizontal Section of a bed showing coils nearing one another.

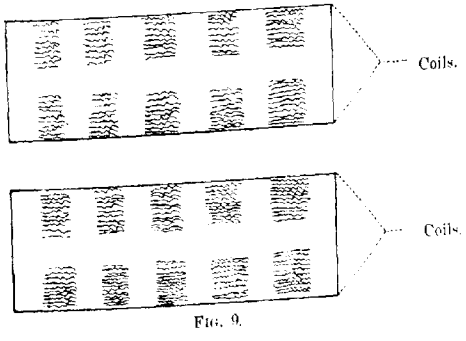

FIG. 9.

Earthing.—In "Chaitra" and "Vaishakh" (*i.e.*, in April and May) earth is put in water-channels and on both sides of the furrows to raise the level of the garden.

Manuring.—In "Jeshtha" and "Ashadh" (*i.e.*, in June and July) manure is supplied to two rows of betel-vines on each side of a bed at the rate of two basketfuls to "Khurg" and "Uchatang" beds, two and a half basketfuls to "Chiratang" bed and three basketfuls to "Ada-Dang" bed. After the application of manure, weeds should be uprooted by "Kurpa."

Leaves at different periods.—In "Chaitra" and "Vaisakh" (*i.e.*, in April and May) the soiled leaves called "Kesara-goli" near the ground are removed as useless.

In "Jeshtha" and "Ashadh" (*i.e.*, in June and July) leaves of medium size known as "Prati-Yeli" are cut and sold. Those cut from "Shravan" to "Magh" (*i.e.*, August to end of February) are sorted as—

(1) Bombay-khuda ; and
(2) "Badira-Yeli."

Bombay-khuda is of superior quality being the pick of the whole lot and "Badira" is the after pick.

Yield and Price.—A good crop yields 240 *daks* (a *dak* is about 15,000 leaves) of the best Bombay-khuda leaves per 60 Chiras,—an acre of 50 Chiras yields 200 *Daks*. An acre also yields 50 *Daks* of "Badira-Yeli," 16 *Daks* of "Prati-Yeli" and 22 *Daks* of "Kesara-goli."

The price of one "Bombay-khuda" *Dak* is on an average Rs. 8, that of "Badira" Rs. 3, that of "Prati-Yeli" Rs. 3 and that of "Kesara-goli" Rs. 2.

A good crop generally brings Rs. 1,600 for "Bombay khuda," Rs. 150 for "Badira," Rs. 48 for "Prati-Yeli" and Rs. 44 for Kesara-goli." The total price of the yield per acre is Rs. 1,902, of which Rs. 60 is on account of feeding two working bullocks with Shevari (*Sesbania ægyptiaca*) branches.

Cost of cultivation and marketing per acre is as follows :—

		Rs.	As.	P.
Four ploughings	8 bullocks plough twice	22	0	0
	6 bullocks plough twice	13	8	0
Harrowing with 8 bullocks, 2 days		5	8	0
Manure, 50 carts		50	0	0
Harrow with 4 bullocks four times		6	0	0
Preparing beds and Chire		25	0	0
Planting sets		25	0	0
Cost of 8,100 sets for 50 Chires at Rs. 20 per 1,000 ...		162	0	0

Watering expenses :—

Two permanent bullocks, Rs. 180 Two permanent men, Rs. 180	... ...	360	0	0
Two men for binding and picking insects		180	0	0

Cost of binding, sending, etc., of *Daks* to Bombay :—

Cutting 288 *Daks* of leaves at As. 4 per *Dak* ...		72	0	0
Cart hire for 200 *Daks* from Chikkodi to Chikkodi Road Station at Re. 1-4 for a cart carrying 12 *Daks* at a time		20	13	4
Railway freight charges from Chikkodi Road to Byculla Station at Rs. 14-0 per *Dak*		250	0	0
Carrying from Byculla Station to stone house (*Vakhar*) @ Re. 0-1-6 per *Dak*		18	12	0
Charity (*Dharm-Dan*) at 6 pies per *Dak*		6	4	0
Brokerage at 15% on Rs. 1,600		240	0	0
Coils prepared from some wild creepers @ As. 4 for 20 sufficient for 10 *Daks*		5	0	0
Bamboo mats for 200 *Daks* at Re. 1 for 12 mats ...		16	10	8
Sugar-cane leaves for outer covering @ ½ anna per *Dak* ...		6	4	0
Grass rope (*Yulikí*) for binding @ Re. 1 for quantity sufficient for 20 *Daks*		10	0	0
Daily 3 men are required for binding 9 *Daks* @ As. 4 per man. Therefore for 200 *Daks*		16	10	8
Rent per acre		20	0	0
Total ...		1,531	6	8
Interest on the sum @ 6% per annum		91	14	2
Grand total ...		1,623	4	10

Net Profit :—

Rs.	As.	P.	
1,902	0	0	Price of yield
1,623	4	10	Outlay.
278	11	2	Net Profit

When 18 months old the vines become fit for plucking. The plantation lasts nearly 8 years. The initial expenses of ploughing, harrowing, forming "Chire," buying and planting sets, etc., are not incurrred every year. This makes the yield remunerative. On an average the net profit per acre comes to Rs. 500.

Pests.—A kind of insect called "Nusi" when young and wingless and "Tibbi" when old and winged, sucks juice on leaves in small patches, and leaves a black spot on them, lowering their value. It has six legs, red neck, pointed proboscis and black body with white stripes on the abdomen and with membraneous wings on the sides. When young, it is red and tender and possesses no wings. Before the wings appear, red protuberances develop on both sides just behind the neck. At this stage it moves actively on young leaves. When wings grow, it flies from one creeper to another, selecting for sucking only young leaves and gradually infects the whole garden.

Remedy.—These insects should be searched and killed every day by a sudden concussion of both the palms. The number of men required for this purpose varies according to the size of the plantation.

2. Another insect is "Bacchi Hula." This usually sticks steadily to stems of shade trees. It emits a very nauseating smell and sometimes blisters the skin if touched. It sucks juice from the stem of the shade trees which look burnt where infected. It also excretes a kind of juice which burns the betel-leaf completely. To destroy this pest the insects should be collected in a tin containing a mixture of cowdung and water. The contents of the tin should be buried in earth.

NOTES.

NOTE ON TAKING SOIL SAMPLES.—When selecting a sample of soil for chemical examination it is desirable to bear two points in mind:

(a) that the specimen shall represent a suitable depth.

(b) that the specimen shall fairly represent the area in question.

The term "area" here refers to any fairly *uniform* area of land. Such an area may be represented by one sample. But supposing two obviously different classes of land lie contiguous to one another, such as a loam and a sandy soil, this would not be one area but two, and one sample would not properly represent both.

Regarding the depth, the surface soil is usually different from the subsoil; it is therefore desirable to take the specimen from one or the other separately. The depth of the *surface soil* varies according to the nature of the cultivation, but a depth of 8 inches will be suitable for most cases. Hence a specimen of surface soil should be cut from the surface of the land to a uniform depth of 8 inches. If a specimen of the subsoil is required, it should be taken from the next soil underlying the surface, but 16 inches deep.

The sample should obviously be so selected that it will be representative of the whole area. The soil varies a good deal from one point in a field to another, and thus if two single specimens are examined, these differences will be observed. One *specimen* is therefore insufficient to represent the whole area, and it is necessary, in order to obtain a knowledge of the general nature of the soil, to select a number of *specimens*. If

these are mixed together, the resulting mixture may be relied upon to provide a safe sample of the whole. Small portions of the surface soil, or the subsoil, should be taken from different parts of the area, mixed carefully together, and a part of the mixture sent for the examination. Regarding the number of such specimens, five or six should be taken from any small area, such as one acre; ten to twenty from larger areas. They are best taken from points at about equal distances from one another in a straight line across the field.

The size of each portion.—Since each inch of soil varies in nature from the surface downwards, it is necessary to take specimens carefully. The simplest plan is to cut out a portion measuring about 4″ × 4″ on the surface and 8 inches deep, in the case of a surface soil; and for subsoils one of like area but 16 inches deep, *i.e.*, from the 9th to 16th inch. The earth should be put into a sack or box, then another similar portion taken from the next selected point and added likewise into the sack, and so on until all the desired portions have been gathered. The whole is then taken out of the sack, carefully mixed together and about 10 pounds sent for examination The same procedure naturally applies to the specimens of subsoil. If the earth is damp, the selected 10 lbs. should be dried in the sun before despatch.

Despatching soil samples.—The simplest mode of transmitting soil is to send it in a small sack, tied at the neck. A piece of paper bearing the sender's name and the number or description of the sample may be folded up and put inside with the earth. This is preferable to tieing a label on the outside, as the latter is easily torn off.—(J. W. LEATHER).

* * *

DEWPONDS.—A paper which must arouse interest in the minds of those who are trying to solve the problem of water-supply in arid countries, appears in the *Journal* of the Royal Society of Arts, March 5th, 1909.

However parched the surface of a country may be, the air above it almost always contains water in the state of vapour.

Mr. G. Hubbard in his paper puts forward a method by which this atmospheric moisture may be condensed on the surface of the earth. This he proposes to do by means of "dewponds." The idea does not seem to be a modern one, for in a book entitled "Neolithic Dewponds and Cattle ways" by Drs. A. J. & G. Hubbard, the authors produce evidence that these ponds furnished the principal water-supply to those pre-historic races who lived on the hill tops on the South Downs thousands of years ago.

In explanation of the word 'dewpond' it will be best to quote here from this book an abstract, which appears in the Journal of the Board of Agriculture for June 1906:

"Dewpond makers commence operations by hollowing out the earth for a space far in excess of the apparent requirements of the proposed pond. They then thickly cover the whole of the hollow with a coating of dry straw. The straw is in its turn covered by a layer of finely puddled clay and this is then strewn with stones. The pond will gradually become filled with water the more rapidly the larger it is, even though no rain may fall."

This water results from the deposition of dew on the cold surface of the clay. The straw is a non-conduction material and the clay bed being separated from the earth by this, becomes much colder at night than the surrounding earth. If the straw becomes wet it will cease to be a non-conductor and in consequence the clay will no longer attract the dew.

To return now to the original paper under review, we find a few of the theoretical considerations. "Aqueous vapour is always being given off from any surface of water until the atmosphere becomes saturated with it. This point of saturation or the "dew point" represents that state of the atmosphere when it cannot contain any additional moisture at a given temperature. This dew point varies with the temperature. The higher the temperature of the air the more moisture it can contain." If we have air saturated with moisture at a given temperature and we then lower the temperature by bringing a cold surface in contact with the air, we get moisture deposited. On this depends the principle of the dewpond. The cold surface of

the clay cools the air in contact with it below its dew point, and moisture is deposited. The clay in the dewpond is colder than the moist body of earth from which it is isolated by straw for the following reason. During the day the earth absorbs heat from the sun's rays. During the night it loses heat by radiation and cools down. If we isolate a small portion of the earth's crust from the main body by means of a non-conducting material, then this small piece will cool much more at night than the main body of the earth, because it cannot receive heat from below.

It is on clear star-light nights that most dew is deposited. On cloudy nights very little is deposited for the clouds tend to prevent the heat radiation from the surface of the earth.

Mr. Hubbard states that at Gibraltar a portion of the rock has been covered with corrugated iron on a wooden backing. On this the warm moisture-laden winds become chilled and the dew is deposited, thus providing Gibraltar with a supply of pure water. The author seems hopeful about useful results in desert and waterless countries generally.

The above are the main points about dewponds discussed in the literature mentioned. The paper originally quoted, however, is so full of interesting points that it deserves to be read by every one interested in water-supply in India.—(H. E. Annett).

* * *

Special Drying Appliances for India.—The following remarks are abstracted from an article entitled "Special Drying Appliances wanted for India" which appears in the *Journal of the Society of Chemical Industry* for the 30th April 1909. It is written by the Director-General of Commercial Intelligence :—

In the rainy season certain industries in India suffer from the difficulty of drying their products or materials.

With regard to the flour-milling industry a special drying plant is necessary. Before wheat in a dirty state can be milled it must not only be screened and scrubbed but washed and the process of subsequent drying is troublesome, costly, and at times injurious. The usual method is to discharge the wet wheat down

a shaft in which it meets a current of hot air. This method however is not successful in the rains.

The tanning industry would also gain greatly by an appliance that would dry the air in the monsoon without reliance on condensation processes. The present mode of drying hides is a slow one and during the drying moulds work considerable mischief.

In the manufacture of sugar deterioration of colour results from the creation of invert sugar during drying.

The article ends with an expression of the hope that some engineering firm will be induced to put on the market drying machines for these and other purposes quoted.—(H. E. Annett).

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Bats' Guano in Burma.—Considerable deposits of this substance are known to exist in different places in Burma. It is largely found in the numerous limestone caves which are found along the range of hills bordering on the Shan States and dividing them from the plains of the Irrawaddy, but in one place at least, near Kyaukse, it is reputed to exist in a broad cleft between the rocks to an unknown depth (said to be several hundred feet). These caves are also numerous near Moulmein, Tavoy and elsewhere in the Tennasserim Division, and in many of them deposits of bats have accumulated to a greater or lesser thickness. In fact, as caves, clefts and other suitable retreats for bats are found in most of the hilly parts of Burma, it is quite probable that the supply of bats' guano may prove to be very considerable indeed.

Though the value of the substance is not unknown to cultivators in some of the finest cultivated districts, owing to the present great difficulties of obtaining it, the quantity used is very small. Many of the beds are almost inaccessible and the material after being dug out has to be carried a long way by coolies. In Kyaukse, where it is used in fruit-gardens, but also sometimes on paddy land, the price asked was one rupee per basket, of about 9 gallons capacity. The weight of a basket varies considerably with the depth from which the material is obtained. The later deposits are uncompressed and in a loose state whilst the older

deposits are more or less solidified. Near Moulmein and Tavoy the chief use of the Guano is to fertilise Durian *(Durio zibethinus)* and other fruit trees in the gardens there, and a small royalty is paid to Government for the right to extract it.

For the purpose of obtaining some idea of the manurial value of the substance, three samples were obtained near Kyaukse

No. I, the new deposit, is of a dry powdery consistency, and on examination numerous particles of the elytra of beetles and the hard outer coverings of other insects are easily distinguishable; in fact, it has the appearance of the ground-up, hard parts of insects.

No. II is an older deposit and has not the same powdery nature as No. I, but is largely solidified, darker brown in colour, and the remains of insects, though still to some extent recognisable, are not so easily distinguished.

No. III, the oldest deposit obtained, is practically one solid mass and is dug out in large lumps. It is of a still darker brown colour and the insect remains are difficult to discern.

The following analyses, made by the Agricultural Chemist, Mandalay, will give the best idea of the manurial value of these three samples:—

RESULT OF ANALYSIS OF GUANO (*Cave deposits*).

	Sample No. I, Upper deposit.	Sample No. II, Middle deposit.	Sample No. III, Lower deposit.
Moisture	15·38	3·73	2·69
Dry Substance—			
* Ash	28·00	52·85	71·94
† Combined water and organic matter.	72·00	47·15	28·06
	100·00	100·00	100·00
* Containing:—			
Percentage on dry matter. P_2O_5 (Phosphoric Acid)..	2·13	1·06	1·62
K_2O (Potash)	·76	·68	·59
Ca O (Lime)	7·89	1·23	1.68
Mg O (Magnesia)	1·55	1·06	·98
Fe_2O_3 (Ferric Oxide)	2·02	2·35	3·90
Sand	13·89	45·34	63·43
† Containing Nitrogen	7·97	4·37	63

As is the case with all Guanos there is probably great variation in the composition of samples obtained from different places.

So far as has been ascertained there is at present little, if any, export of the substance to other countries.—(E. THOMPSTONE).

* * *

THE SILK INDUSTRY.—In the *Commercial America* for June 1909 is published a short review of the trade in raw materials and manufactured products of silk in various countries. Figures are given of the world's production and consumption of this article during 1908. The following table refers to the production and consumption* of raw silk :—

Production.			Consumption.		
China	29	million pounds	United States	18·8	million pounds.
Japan	25	,, ,,	China	16·4	,, ,,
Italy	10	,, ,,	Japan	10·1	,, ,,
Levant	5·6	,, ,,	France	10·0	,, ,,
Indo-China	2·4	,, ,,	Italy	7·9	,, ,,
Europe, n.e.s	2·4	,, ,,	Germany	7·4	,, ,,
France	1·4	,, ,,	Europe, n.e.s.	3·2	,, ,,
Other countries	1·2	,, ,,	India	1·1	,, ,,
	77		Other countries	2·1	,, ,,
				77	

The total quantity is about 77,000,000 pounds, and it will be seen that the supply continues to keep pace with the demand. The statistics of production and consumption during the last ten years show an increase under both these headings, but particularly under that of production which gives an increase of 30 per cent. in a decade. China is the largest raw silk-producing country in the world, Japan taking the second place. The only other countries in which the industry is conducted on a large scale are Italy and France. But neither China, nor Italy, nor France has shown such phenomenal progress in the industry as Japan. In fact, of all the articles which she exports to other countries, raw silk and silk fabrics represent the highest money value. A study of her trade

* The consumption of raw silk in any country may easily be ascertained by a very simple formula : Add the yield of the cocoon crop to the excess of imports over exports of raw silk, plus the excess of imports over exports of foreign cocoons, less the amount of thrown silk exported from the country.

statistics goes to show that out of the total exports of the country in 1906 which amounted to £43,258,000, more than ¼ represents the value of silk. During 1908, she exported about 11 million pounds of silk valued at 5 millions sterling to the United States only, which is now by far her largest customer. Her export trade, which is considerable, is organised into three groups, *viz.*, (1) the factories scattered throughout the country which sell to (2) the Japanese middlemen who take a commission of about 1 per cent and in turn to (3) the foreign and Japanese exporters in Yokohama. During recent years, the Japanese have been gradually bringing the trade into their own hands. For further details in connection with the Raw Silk Industry of Japan, we would invite the reader's attention to an interesting report by Mr. G. P. Paton which has just been published as a Diplomatic and Consular Report—No. 672, Miscellaneous Series. The writer of the report attributes the success of the industry to (1) the suitability of the climate and the country for the production of the mulberry and the rearing of the silkworm: (2) the supervision, fostering and encouragement which the industry receives from the Government and (3) the almost inexhaustible amount of cheap labour that can be easily and quickly trained. To this may perhaps be added the instinctively artistic habits of the Japanese and their powers of ready adaptability. In his recent work *Japan — Its Commercial Development and Prospects* (Sisley's Ltd., London, 2/6 net). Takashi Masuda lays particular stress on the last of these factors and observes that the development of the industry would have been well nigh hopeless but for this. He further remarks that the retrogression in the silk industry of France and Italy is due to the want of aptitude on the part of the people and the comparatively high prices of food-stuffs. "In almost every district of Japan, the farmers themselves will be found engaged in the cultivation of rice and other grain forming the staple food of the people, while their families will be busily occupied with the rearing of silkworms, thus putting into practice the ideal recorded in ancient history of a wise Emperor himself

tilling the ground for rice-growing in the palace garden in order to get a knowledge of the actual conditions of farming, and of an Empress with her Court ladies engaging in rearing silk-worms as a practical lesson in sericulture."

Turning from production to consumption, we find that the United States takes the lead. Several efforts to make the raising of silk locally a commercial success appear to have ended in failure, and she is now entirely dependent on other countries for her supply of raw silk.

As regards the value of silk products manufactured in the various countries, no reliable data are available, but it is stated that the leading manufacturing nations—leaving China out—are the United States, France, Germany, Switzerland, Italy, Japan, Russia, India, Indo-China, Great Britain and Austria. The imports and exports of nine leading countries for the last two years, showing the values of silk and silk goods (both manufactured and unmanufactured) in millions of dollars are given in a table which is extracted below :

		Imports	Exports.
France	1907	96	116
	1908	69	104
Italy	1907	48	130
	1908	46	124
Germany	1907	55	61
	1908	66	52
United States	1907	114	...
	1908	92	...
Switzerland	1907	44	57
	1908	30	43
Great Britain	1907	72	12
	1908	67	8
Japan	1907	17	77
	1908	13	74
China	1907	...	71
Austria	1907	22	9
	1908	23	10

In the above table, the United States does not appear in the *export* trade though it is the largest silk manufacturing nation in the world, the value of the output being estimated at more than 130 million dollars in 1908. This is due to the fact that her products are barely sufficient to supply the wants of her own people. In the case of a number of other countries,

e.g., Japan, China, Italy and Switzerland, the exports of silk form an important factor in the trade of the country, and the prosperity of the people of these countries depends in a large measure upon the silk crop.

In glancing over the facts and figures given above, one is naturally tempted to ask why India does not figure prominently in the silk trade. In the latter part of the eighteenth and the beginning of the nineteenth century, she appears to have had a flourishing trade in this commodity. In his *Commercial Products of India*, Sir George Watt gives the figures of foreign trade at this period. Bengal was then, as it is now, the great silk-producing province in India. In 1805, the total exports of Bengal silk into London alone was 835,904 pounds. The trade was controlled by the East India Company till 1835, but in this year they having given up direct control over the industry, the trade began to decline. The quality of the silk also began to deteriorate on account of the havoc played by disease. In 1867, the quantity of raw silk exported from India was 2,226,201 lbs. valued at Rs. 1,55,32,290. In 1881, the total exports were 551,000 lbs. reeled silk and 788,000 lbs of waste silk, valued at 55 lakhs. Thus, within a period of less than twenty years, the exports declined from a valuation of $1\frac{1}{2}$ millions to $\frac{1}{2}$ a million sterling. The figures of foreign trade during the last decade are given below :

Years.	Raw Silk.		Manufactured Silk.	
	Exports.	Imports.	Exports.	Imports.
	Rs.	Rs.	Rs.	Rs.
1900-1	51,22,057	1,01,69,402	12,54,447	1,66,58,108
1901-2	66,34,209	80,96,200	10,54,694	1,48,47,009
1902-3	65,47,753	55,16,149	9,48,851	1 63,23,232
1903-4	63,42,468	59,29,527	8,32,669	1,83,34,720
1904-5	49,69,975	73,41,121	7,48,281	2,11,81,502
1905-6	56,39,679	71,19,049	7,15,169	1,90,15,100
1906-7	68 65,018	56,80,273	6,86,072	1,82,50,465
1907-8	63,78,000	98,15,000	8,31,000	2,13,49 000
1908-9	54,65 000	1,01,89,000	7,33,000	2,28,14,000

It is not intended to discuss here the factors which have operated in the decline of the silk trade, as these are complex and

require to be carefully dwelt upon at some length. We may however emphasise the obvious moral which a perusal of the figures in the above table presents. There has been a steady *decrease in the exports* of both raw and manufactured silk, and a corresponding *increase in imports*. During the past nine years we have been importing to this country, on an average, some 75 lakhs worth of raw silk and nearly 2 crores worth of manufactured silk. More than four-fifths of the former comes from China in the form of yellow silk, and of the latter, more than a third comes from Japan,—China, France and the United Kingdom making up the remainder. Is it not possible to raise in this country all the raw silk which we import from China? When it is considered that more than the quantity of raw silk now imported was at one time being exported from this country, we cannot but answer in the affirmative.

Then again, there is a steady increase in the imports of manufactured silk. This has been so for the last half a century and more, and there is a corresponding decline in the silk manufacture in this country. There seems to be no special reason why it should not be possible to manufacture silk goods in this country just the same as cotton goods.

It may be hoped that through the generous assistance of Government and the scientific methods now adopted in several parts of India, the decadent weaving industry will be revived and the Sericultural industry placed again on a firm footing.—(C. S. RAGHUNATHA RAO).

***

PREPARATION AND PACKING OF SPECIMENS OF PLANTS AND INSECTS.—The following Note by Mr. E. J. Woodhouse, Economic Botanist, Bengal, on the preparation and packing of specimens of plants and insects, has been issued by the Bengal Department of Agriculture in their leaflet No. 3 of 1909 :—

"*In the past year it has been found possible to give very little* immediate assistance to those who have asked for advice concerning insect or fungus attacks, owing to the fact that the specimens

have usually arrived too late and in too bad a condition for identification, but it is hoped that during the coming season specimens of the diseased plants and information concerning them will be at once forwarded direct to the addresses given below, when it will be possible to give a scientific opinion on them in a much shorter time than has hitherto been possible. The necessary information concerning the packing and preparation of the specimens and the addresses to which they are to be sent are given below.

"1. *General.*—If it is desired to obtain advice as to the economic value of a plant, a complete specimen of the plant should be taken including a twig with leaves, flowers and ripe fruits, or if this is not available, a specimen of the flowers and leaves should be sent, and where possible some fruits. The specimen should then be immediately spread out flat between two pieces of blotting paper under pressure, the blotting paper being changed as soon as it becomes moist. After a few days the dried specimen will be ready to be sent off packed in thin paper within thick card-boards to keep the whole specimen flat; the fruits may be enclosed in an envelope or separate box, and all should be sent to me at Bhagalpur.

"2. *Fungus Diseases.*—In the case of specimens attacked by fungoid diseases, the specimen should for the present be sent straight to the Assistant Mycologist to the Government of Bengal, Laboratory of the Imperial Mycologist, Pusa, until accommodation can be provided at Sabour.

"In collecting and preparing specimens of the numerous species of fungi which grow upon the leaves, the leaves are to be dried between sheets of absorbent paper (blotting paper will do), sufficient pressure being applied to keep the leaves flat.

"In the case of Rusts (diseases in which the leaves or stems of cereals and other crops become covered with yellow or brown dusty patches), the entire affected plant should be collected, pressed and dried as above.

"In the case of Smuts and Bunts (diseases in which special parts of plants, especially the flowers, become changed into dusty black masses) the affected part or the entire plant should be

collected, pressed and dried as above. In the case of sugarcane the affected part only may be collected, or entire plants may be collected and packed in the usual way.

"In the case of wilt diseases of rahar, gram, gingelly, and cotton in which the plants are seen drying up and withering away without apparent cause, the entire plant with its roots must be collected. In this case it should be noted that it is only in the old specimens, which are far advanced in the disease, that the ripe stage of the fungus can be found.

"The very minute forms belonging to some groups of fungi, which to the naked eye appear as black or red points on the bark or wood, must be cut away with a sufficient part of the host plant to show the general habit of the species. These pieces of bark, etc., must be thoroughly dried before being sent off.

"In the case of many fungi, of which the fruits issue through the stomata, or breathing pores, of the leaves and appear as white, brown or blackish patches, the entire plant with affected leaves should be collected, pressed and dried as above.

"As soon as a specimen is collected, a label bearing the name of the host plant (either in English or the vernacular), date of collection, place where specimen was collected, and any other particulars in connection with the host plant or parasite (such as the approximate date of the commencement of the attack, the amount of injury done, occurrence of the same disease in previous years in the same locality or its neighbourhood, any remedy practised or tried by the cultivators, any marked change in the crop since the commencement of the disease; whether the seeds were selected from a crop affected with the same disease, etc.), should be written on the paper to be enclosed with the specimen.

"If the specimens are to be kept for some time before they are despatched, each paper containing the specimen should be examined every now and then, and a small quantity of powdered napthalene should be put in each paper as a preventive measure against insects, etc. The specimens should be kept in a place where light and air have free access, and should not be kept in damp or dark places.

"Some fungi may well be preserved in spirit and for that rectified spirit is recommended, but rectified spirit is a little costly and is not available in quantity everywhere, so that methylated spirit may be used in its place.

"In packing and despatching, the specimens should be packed flat in their drying papers, care being taken to see that all the specimens lie within the paper. The specimens should then be well wrapped in packing paper and tied with twine before being packed and despatched.

"3. *Insects.*— In the case of insect attacks, the specimens of the insect should be sent without loss of time direct to the Assistant Entomologist to the Government of Bengal, Laboratory of the Imperial Entomologist, Pusa, until the Laboratory at Sabour is opened.

"Insect specimens may be sent either alive or in spirit. To accommodate living specimens, a strong square cardboard or dealwood box or a strong tin is preferable: the box should be perforated on all sides with minute holes to admit of ample ventilation. Specimens should never be sent in tins within the lids soldered down.

"Insects are generally found damaging crops either as surface-feeder (on the leaf, flowers, etc.,) or boring into stems or feeding under the earth on the roots or stems. In the case of surface feeders, the insects should be collected and enclosed in the box with a good supply of fresh food, but the contents should not be too compact, and some dry straw or similar material should be enclosed to absorb moisture. Among surface-feeders there are some which cannot be easily detached from the plant's surface owing to the minuteness and softness of their bodies; in such cases portions of the plant bearing the insects should be collected and packed firmly in boxes with plenty of air spaces. Insects boring into stems or fruits should be collected by cutting off the portions of the plant in which they are living. If there be any characteristic appearance due to the borer, apart from the portion in which they are found, such portions of the entire plants should be enclosed as well. Those feeding on roots or

stems should be collected and enclosed together with the roots or stems Of the underground insects there are some which cannot live without earth, and in such cases loose moist earth sufficient to fill the box should be put loosely in the box with the roots or parts of the plants on which they are found to feed.

"In all cases before packing a slip of paper with information concerning the crop attacked and number and date of forwarding letter in which further details are to be found should be enclosed in the box. The perforated box or tin may then be sewn up in one layer of wide-holed muslin, and addressed in a legible handwriting.

"Living specimens should always be despatched on the actual day of collection, and all specimens should be sent by the quickest routes, by post if possible.

"Preserved specimens are more easy to send, and when collected, they should be put in a glass-phial with a well-fitting cork containing either 40 per cent. formalin and water (1 to 15, methylated spirit or alcohol). The phial should then be packed in a strong wooden case, care being taken to surround the phial with enough materials (such as straw, wood scrapings, cotton wool or the like) to avoid breakage. A similar piece of paper with brief reference as before should be enclosed. Whenever possible, it is better to send a large number of both living and preserved specimens.

"The forwarding letter should contain information on the following points:—Date of collection: locality: approximate date of the commencement of the attack; amount of injury done: nature of injury, *i.e.*, how and where found feeding: occurrence in previous years in the same locality or elsewhere: any remedy practised by the cultivators; any other information available regarding their habits as found in the fields.

"4. *Work in hand.*—Work in this laboratory is being at present confined to the collection of the crops and fibre plants of Bengal, together with some special preliminary work on the cucurbits, mangoes and rices: and assistance in the shape of specimens and information will be always welcome."

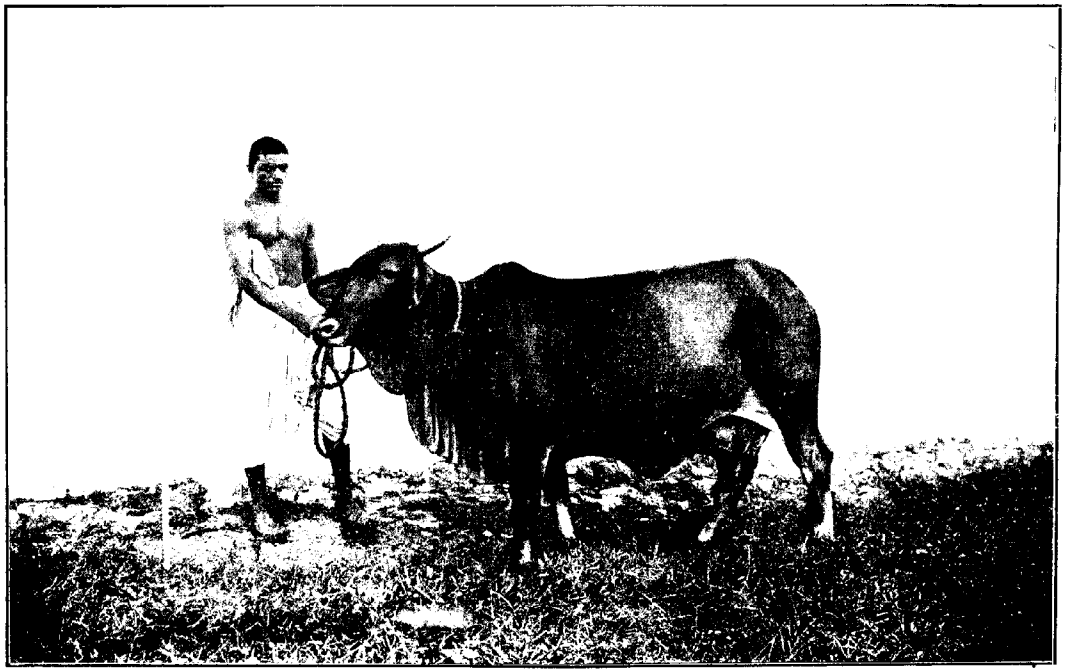
RECENT EXPORTS OF HIGH CLASS INDIAN CATTLE.—During late years there has been a considerable and increasing exportation of the best of our Indian breeds of cattle to various parts of the world. The agents deputed to select these cattle have paid and are paying very high prices for those selected. The exports have chiefly gone to Africa, North and South America, the Straits Settlements, the West Indies and the Dutch East Indies.

No harm to India is being done as a demand of this sort must encourage the breeding of high class cattle if it is definitely made known to breeders that the demand is likely to continue.

Professor Wallace, of Edinburgh, who is at present travelling in America, communicates the following information from Chicago :—"I have seen on the Pierce Estate, Texas, a lot of 23 pure bred Indian cattle, nearly all bulls, which at great expense were imported by the Trustee, Mr. A. P. Bordin, fully two years ago. The Gujarat, Hissar, Krishna Valley, Nellore and Gir breeds are all represented. The crossing with the "range" cows of the country has been most successful. The young cattle are a decided improvement in size on the indigenous stock. Ticks do not live on them and flies do not trouble them much. I really think that the Indian cross is the one for the hot Southern States where European cattle do not do well, cannot keep fat and do not breed regularly. This is very much the same problem as I found in Rhodesia last year, and it may probably be solved by obtaining a strong blend of Indian blood."

The justly reputed Gujarat and Nellore breeds which have the advantage of being found near the shipping ports have hitherto been most in demand for export. They are not heavy milkers, but they are unsurpassed in India as draught cattle, and for this purpose and for crossing with the range cattle they are becoming popular abroad. India is not usually regarded as the home of milch breeds, and the tendency has been to import (with the scantiest of success) rather than to export the latter, but from Karachi considerable numbers of Sindi cows, the best of which

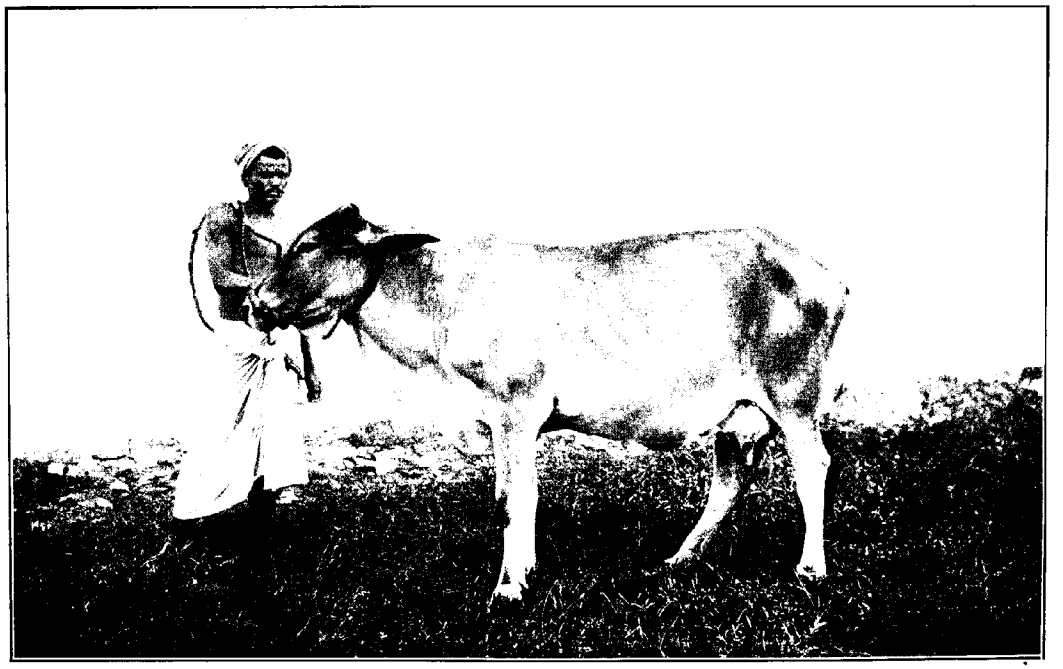
PLATE XXXVII.



A. J. I.

MONTGOMERY COW "HOOSNI," PUSA HERD. YIELD DURING LAST LACTATION PERIOD (11 months), 5,740 lbs.

PLATE XXXVIII.



A. J. L.

MONTGOMERY COW "GONGEL," PUSA HERD. YIELD DURING LAST LACTATION PERIOD (11 months), 6,360 lbs.

are good milkers, find their way every year to the Dutch East Indies. If India can produce a really good strain of milch cow, there is little doubt that there will be large demand for it at remunerative prices, in America and Africa and the East and West Indian Islands. In the Montgomery breed, which is closely related to the Sindi breed mentioned above, we have the material from which to develop such a strain. The average yield of milk in the Pusa herd of 39 Montgomery cows last year was over 4,000lbs. One cow gave 6,300lbs., another 5,700lbs. and several over 5,000lbs. In Mr. Keventer's herd at Simla a Montgomery cow gave just about 7,000lbs. in her last milking period. The percentage of butter fat in the milk is high, averaging probably 4·5 to 5 per cent. Montgomery cattle are small and shapely, having well-developed bodies supported on rather short clean legs. The head is neat, with fairly short horns, and the tail is long and thin almost sweeping the ground. There is a wide range of colours including red, red and white, black, black and white, white, grey and various spotted colours, but the best cows are perhaps most frequently red or red and white. The cows are exceptionally docile and good-tempered. The young stock mature comparatively early, heifers at Pusa having their first calves at $2\frac{1}{2}$ to 3 years old. The male stock develop into good work cattle. The breed seems to adapt itself very readily to changes of climate, doing well in the arid tracts of its original home in the Montgomery District of the Punjab, in the moist climate of Behar and at altitudes of over 7,000 feet in the Himalayas. —(E. Shearer).

* * *

Artificial Fertilizers in Madras.—The Madras Government have sanctioned Rs. 1,000 for a continuation during the current year of the experiments with manurial substitutes for the *Patti mannu* (manurial earth) of the Krishna Delta. Last year the artificial manures were applied in several villages near Ellore and Bezwada. On account of late receipt of the manure the results were unsatisfactory at Ellore. At Kankipaid and Uppalur near Bezwada, the manures produced excellent crops.

Mr. Harrison, Agricultural Chemist, after examination of the manured plots, reported as follows :—

"*Patti Mannu* is applied only once in a sequence of about six years, so that fields recently manured with it have had approximately six times the amount of plant food given to them, that is given to the fields to which the substitutes were applied. Further, in many of the comparisons instituted the crop produced by the substitute was compared with the crop given by *Patti Mannu* in the second year after the application when the maximum effect is felt. Under these circumstances, the fact that the crops produced by the substitutes are generally equal to, or slightly better than, the *Patti Mannu* crops, may be taken as very encouraging and as indicating that complete success will be achieved in the endeavours to place in the hands of the ryots a good substitute for *Patti Mannu*."

Where *Patti Mannu*, however, is still readily available, it is much cheaper than the substitutes. The efforts of the Agricultural Department in the current year will, therefore, be directed, first, to introducing the substitutes into those parts of the delta where Patti Mannu is practically unobtainable, and secondly, to reducing the costs of the substitutes. At Uppalur where the mixtures were applied last year, experiments will be made to test (*a*) the cumulative effect and (*b*) the residual effect of the substitutes. Elsewhere, experiments will be made to determine which of the two manurial ingredients in the mixtures, *viz.*, potash and phosphoric acid is the more important for the paddy crops under the conditions existing in the delta, and whether nitrogen can be omitted from the mixtures by growing sun hemp as fodder after the paddy is cut.—(EDITOR).

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THE PRESERVATION AND CURING OF FISH.—In the January number of this Journal a note was published on the results of the investigations carried on by Sir Frederick Nicholson in regard to the establishment of a Marine Fisheries Experimental Station in the Madras Presidency. He has now brought out a pamphlet describing the various "processes and substances used or available for the preservation of fish from taint, from the moment of catching to the moment of consumption." These processes vary in different localities, but those described in the pamphlet are specially applicable to South India.

In the first chapter the author states the following "Axioms" or general principles for preserving fish":—

(1) The product sought should be food of the most wholesome character, at the cheapest rate for the masses, and of higher price for the well-to-do.

(2) Fish for sale as fresh must be really fresh, *i.e.*, firm and sweet, not soft and pasty, on reaching the market.

(3) Fish to be cured must reach the factory fresh.

(4) It must remain free from taint until it reaches the consumer.

(5) It must not be injurious to health either in itself or in its preservatives.

(6) It must be agreeable to popular tastes.

(7) The method of preserving and curing should be simple and cheap.

(8) The price of cured fish should be cheap.

These objects can be attained by adopting the following precautions:

(1) The fish must be treated throughout, from catching up to market, with care.

(2) Perfect *cleanliness* is required in the boats, markets, factories, and labourers.

(3) If caught alive, it should, if possible, be conveyed to shore alive.

(4) If not kept alive, it should, if large enough, be killed, gutted, bled, cleaned and (antiseptically) washed at once on the fishing boat, and protected from sun and flies, etc.

(5) It should be taken with all speed to the market, icing house, or factory; fish for curing should not be hawked about till no longer fresh.

(6) Fish should be cured in the factory with speed and thoroughness.

(7) Cured products must be prepared to suit the expected market, the season of the year, and their intended keeping power.

(8) New methods and processes should be tried to avoid taint and to suit new or old markets.

(9) Preservative methods should not introduce drugs or materials injurious to health and should leave the nutritive qualities of the fish unimpaired.

(10) Products should be agreeable to the consumers; new goods should be gradually introduced to favourable localities: they should be attractive in appearance, packing and labelling.

(11) The persons employed for curing should be free from contagious or other diseases.

(12) Processes and plant for curing should be simple and cheap, that is, within the means and knowledge of the dealers and curers.

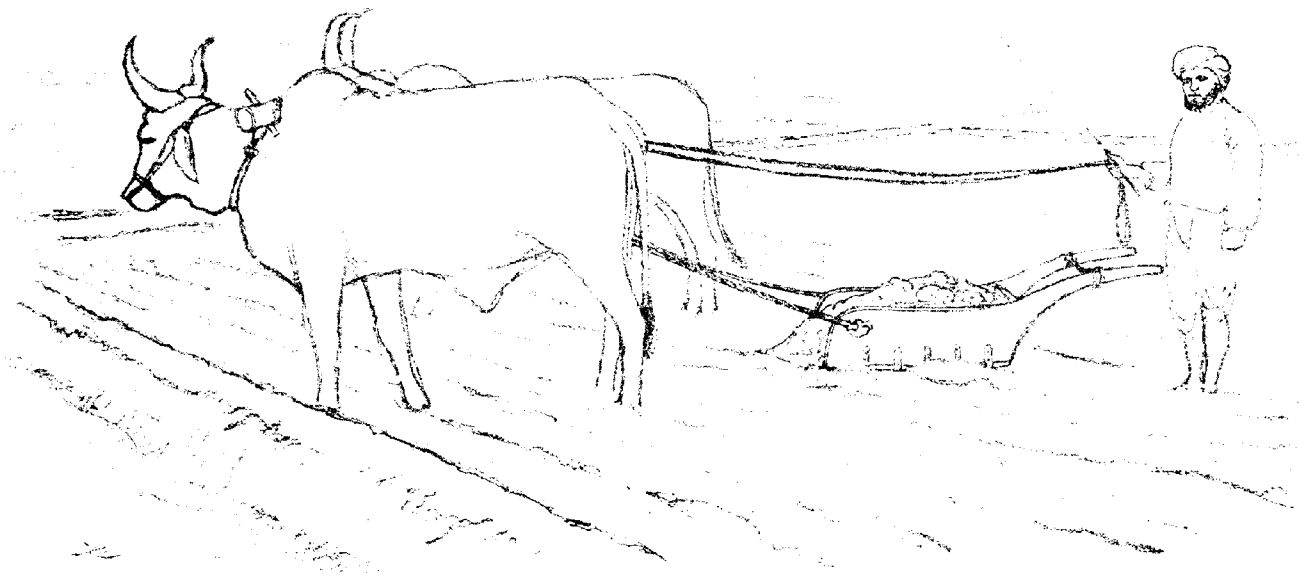
(13) Large markets depend on low prices, but cheapness must be obtained without the sacrifice of good quality.

The second and third chapters deal with putrefaction and the use of preservatives. Chapters IV to IX deal with the methods of preservation, refrigeration, desiccation and sterilization. The various methods of curing fish, including canning, are discussed in the four succeeding chapters. In the last chapter the technical terms employed have been explained. Appendices contain an up-to-date bibliography on the subject, and a Note by James Hornell, F.L.S., on the Japanese method of curing fish.

During 1908-09 India imported no less than 25,573,248lbs. of salt fish valued at Rs. 27,58,839. The imports during the previous five years are as follows :—

1903-04	...	...	...	Rs.	19,73,508
1904-05	..	...	...	,,	24,97,669
1905-06	...	...	...	,,	30,86,066
1906-07	...	...	...	,,	22,84,904
1907-08	...	...	...	,,	27,18,274

More than 90 per cent. of these imports came from the Straits Settlements. Besides, large quantities of canned and unsalted fish are also imported each year from Persia and Arabia.—(EDITOR).

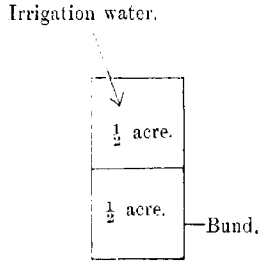


SCRAPER IN SIND—FILLING.

THE 'GASSIBIAH' OR SCRAPER FOR LEVELLING LAND.—This implement is especially important on irrigated land. On a perennial canal, in particular, it is essential that the fields should be quite level, otherwise it is impossible to give a uniform watering to any crop. Watering unlevel ground is not only a very common source of much waste of water, but is also injurious to the crops and is apt to favour the accumulation of *kallar* or alkali at one end of the field. It is a not uncommon sight to see crops being watered 10—12″ deep at one end of the field and dry at the other.

On the other hand, dividing up the land according to its natural level into small irregular patches is exceedingly wasteful both of land and water.

If, however, the land were divided into rectangular plots and properly levelled to begin with, the result would be much more satisfactory. It has been found that on average land 4 scrapers, and 1 plough working in front of them, will level and put bunds round, and one bund across, one acre per day.



These bunds are permanent and so save the expense of renewing for every crop, and are much less likely to break with the consequent wastage of water.

The scraper is a box-shaped arrangement, the sides being 2′ long and 9″ high and are continued into handles 3′ long, the ends being 2′ from the ground. At the latter point they are 1′ 8″ apart and at the gathering edge 2½′. The bottom is convex and is formed of strips of wood nailed to the sides and protected with sheet iron strips. The gathering edge is of iron 4″ wide. This implement was designed from an Egyptian pattern and is being

made and distributed from the Mirpurkhas Farm. Plates XXXIX and XL clearly show its construction and working. When filled with earth, it is simply tipped over and the soil may either be spread out gradually or put in one place to make a bund. A rope is fixed across the handle which rests on the draft chain when returning empty. The scraper can also be used for grading roads or making embankments.—(G. S. HENDERSON).

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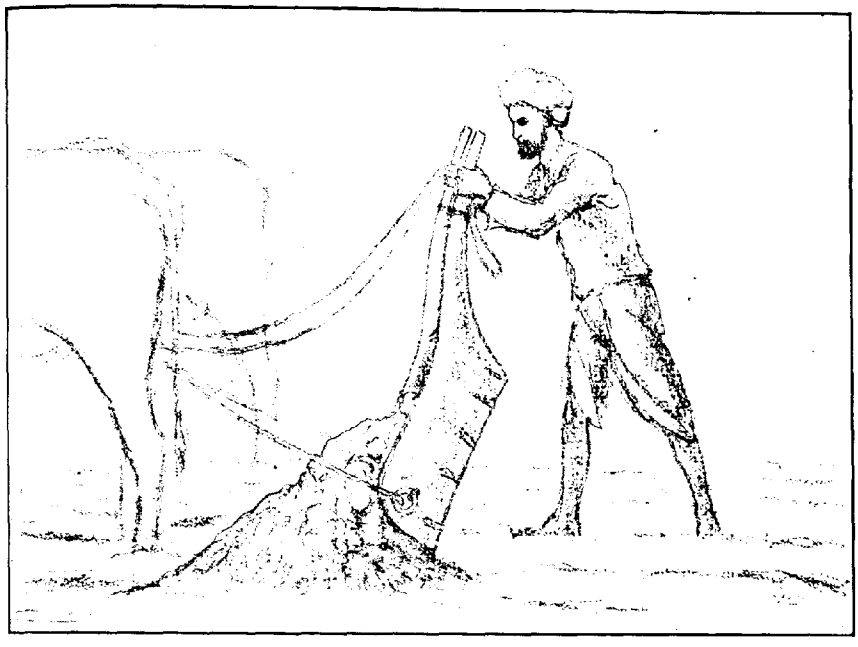
OIL ENGINE AND PUMP.—In the April number of the *Agricultural Journal of India* there is a controversy about a 2" centrifugal pump worked by an oil-engine for irrigation. As a person of some experience in machinery, I venture to express my opinion on the question which I consider to be of importance to agriculture.

A 2" centrifugal pump is a toy and should not be used for irrigation. Such a pump at 1,350 revolutions will raise to a height of about 18 or 19 feet about 80 gallons per minute—4 800 gallons per hour, or 48,000 gallons per day of 10 hours. If this is all the water that is required in a day, it is best to use one or two *Mhotes* or a Persian wheel or chain pump. But if time be of more importance than the amount of initial outlay, then I would increase my outlay by about 30 or 40 per cent. and use a 5" centrifugal pump and a correspondingly larger oil engine, provided there be an adequate water-supply. By doing this I will increase my capacity about ten times; do my irrigation in about an hour and-a-half, and set free my men for other work during the rest of the day.

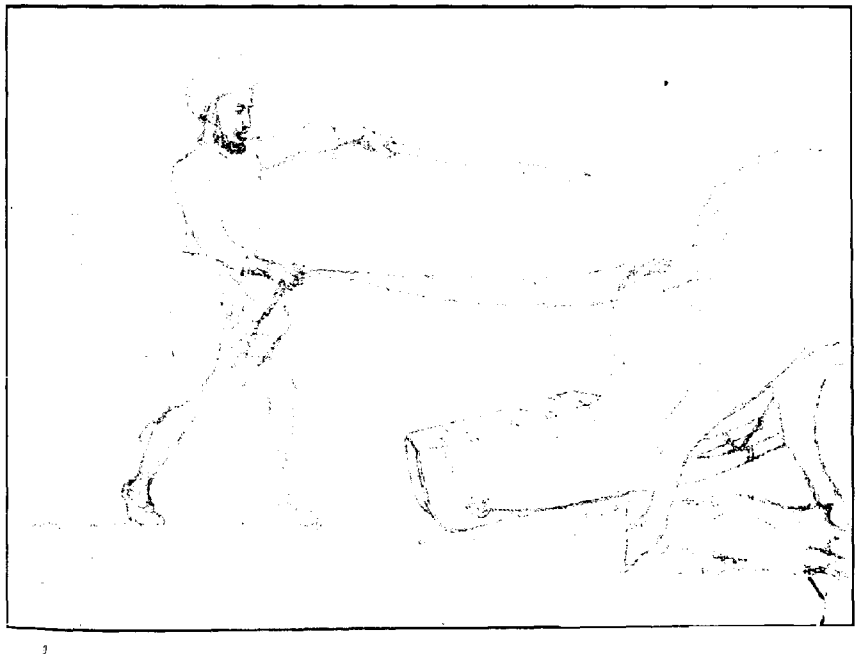
There are other advantages to be gained by the use of a larger pump and engine. The cost per gallon of water raised will be cheaper; I may at a future date require more water; or I may be able to supply my neighbour with water; or I may have to use the bigger engine for working a saw bench, an oil press, a cane crusher, a threshing machine or any other machine requiring power.

As regards the difficulties of skilled labour and repairs, this consideration need not stand in the way. Any intelligent man

PLATE XL.



SCRAPER IN SIND—EMPTYING.



A. F. I. SCRAPER IN SIND—RETURNING EMPTY.

can learn to work an oil engine in a few days, and when once started, unlike a steam engine, it requires very little attention. There is an oil engine working an ice and soda water factory here for the last 12 years: it has given no trouble, nor does it require any repairs to speak of. If the engine is kept clean and carefully used, no trouble need be expected.

If the supply of water be not sufficient for a 5" centrifugal and yet a pump be required, I would recommend a hot air pump which is simple and economical, and once started, requires no further attention. A $2\frac{1}{2}$" pump will raise about 3,500 gallons per hour and will cost about Rs. 1,600, which compares very favourably with the price of a 2" centrifugal pump and oil engine.

I am entirely in favour of employing oil engines on farms because they can supply power for a variety of purposes. I would recommend that every experimental farm should have one, and the teaching of its working should form part of the duties of the Farm Manager.

I do not approve of the method adopted on Government Farms for calculating the working expenses of these engines at so much per gallon of water raised as against so much by *mhote*. The only way to judge its utility is to consider the work your engine can do in the course of the year, taking into account good and bad times, and the amount of time it can save.—(KHAN BAHADUR MIRZA ABDUL HOSSEIN).

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REPORT ON THE SHILLONG SHOW, 1909.—The Annual Show of Field and Garden Crops, Livestock, etc., was held at the end of May 1909, at Shillong.

The cattle, horses, sheep and goats were penned in open enclosures. Mr. W. Harris, Veterinary Superintendent, has pointed out that it would be very desirable to have all livestock under cover as it is difficult to judge them when wet and rain spoils their appearance from a show point of view.

The poultry were penned in temporary structures of sticks with wire-netting over the front and top. Leaves were spread

over the top of the pens to protect the birds from the rain, but this was not very effective, and nothing spoils the appearance of the fowls so much as a shower of rain.

As was the case last year, livestock was shown only on the first day and flowers on the second day.

This year a very important feature of the show was the demonstration of various new agricultural implements and machines. The Farm Superintendent, Shillong, was in charge of this section. The machines exhibited included a maize crusher, maize sheller, planet junior hand hoe and a spraying machine. These machines were worked on the show ground at certain hours each day, and attracted large numbers of enquiring cultivators. For the purpose of demonstrating the use of the spraying machine, a small area of potatoes had been planted some time beforehand on the show ground. The Bordeaux mixture which is used for spraying potatoes with the object of checking disease was made up in the presence of the spectators, and the whole process was explained to them by the Farm Superintendent in their own language.

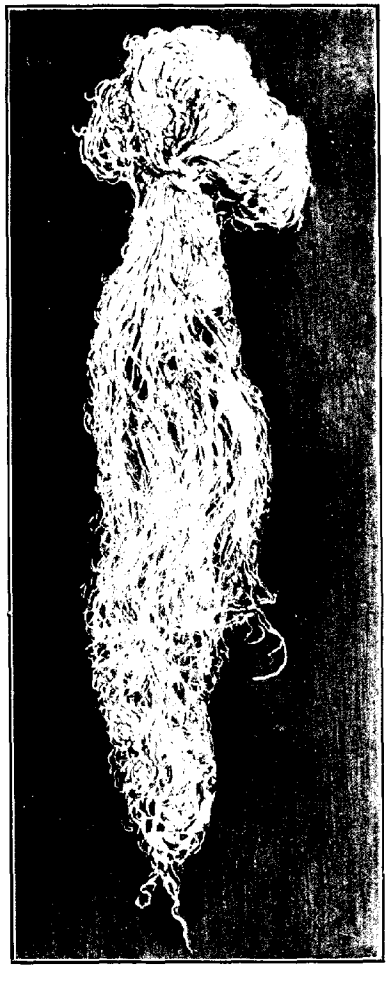
With the object of interesting and instructing the people in matters agricultural, various leaflets published by the Department, both in English and Khasi, were displayed in a prominent position in one of the sheds, and an assistant was placed in charge of these to answer enquiries and to distribute copies.

The attendance at the show was not so large as in previous years. This is to be regretted. Probably a personal appeal to the Chiefs of the Native Khasi States would be productive of an increase both in the number of exhibitors and of spectators.

The exhibits in the section of field crops were numerous and, on the whole, excellent. Fruit exhibits were very poor with the exception of plantains. A considerable improvement is noted in the quality of the vegetables brought in by Khasis to the show.

The cattle shown were poor ; there is much room for improvement in the cattle of the district. Poultry showed a great improvement on last year. Several good samples of butter were

PLATE XLI.



A. J. I.

RAMIE FIBRE FROM DHOLPUR.

shown and one or two fairly good cream cheeses. There were three or four excellent exhibits of honey, one sample of honey in the comb being particularly good.—(A. G. BIRT).

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RAMIE CULTIVATION IN INDIA.—*Boehmeria nivea var. tenacissinia* (Ramie) is a nettle (urtica) plant easy of cultivation in the sandy soil and dry climate of India.

I planted it on a sandy soil in Dholpur near a well. The experiment was successful. A sample of the fibre with its photograph is submitted for inspection to the Inspector-General of Agriculture in India. The seed is very small and germinates within ten days.

To secure germination the seed should be sown mixed in equal proportion with white sand, in a seed pan or a box about three inches deep, containing well-prepared soil. The seed should not be closely sown. The seedlings require watering and should be shaded. They should be transplanted when one to two inches high to a small pot containing well-prepared soil, and irrigated. About five months after, the plants should be planted four feet apart on well-ploughed land. They require watering three to four times a month to produce full growth. When full grown, watering is required twice in hot weather and once in cold weather. This plant can be multiplied by cuttings and division of roots. The cuttings strike easily if kept moist in good soil in shade. The raising of the stock from the division of roots is also easy. The plants raised from the division of roots are stronger than those raised from the cuttings.

The lateral shoots should not be allowed to sprout from those plants from which the fibre is to be obtained, as they shorten the stems. In an established plantation, the stems begin to mature at six months of age and continue to do so all the year round. The stems should be cut close to the root when mature. They should be dried in the shade, and their leaves removed. The dried stems should be steeped in water for about 12 hours. When soft their ribbons can be drawn out.—(T. N. BHAN.)

REVIEWS.

DISTRIBUTION OF WATER IN THE SOIL IN FURROW IRRIGATION BY R. H. LOUGHRIDGE.—BULLETIN 203, OFFICE OF EXPERIMENT STATIONS, U. S. DEPARTMENT OF AGRICULTURE, 1908.

THIS bulletin deals with a portion of the investigations now being carried out in Southern California in connection with the irrigation of orchards and is a part of a general study of the losses of water in irrigation and their prevention. The general conditions in this tract are not unlike those in many irrigated parts of India where the limit of water supply has been reached and where any extension of cultivation is only possible through greater economy in the use of the present supply. This bulletin is, therefore, of interest to all in India who were concerned with irrigation. During the progress of the work it was observed that "the application of irrigation water together with the shallow ploughing to the same depth year after year, has a tendency to work the clay down to the subsoil to 1, 2, or 3 feet deep, and this being repeated year after year causes an accumulation of the clay not far below the surface. This clay, on drying, forms a kind of plough sole hardpan or "irrigation hardpan," which is in some orchards very slowly penetrated by water. In other orchards the clay and grit become so firmly compacted as to resist completely the passage of water through the mass." The obvious remedy is the occasional breaking up of this compact subsoil and in such tracts as the Punjab canal colonies it would be interesting to explore the subsoil and to see if an occasional deep ploughing would have a good effect on the wheat crop.

As has been noticed at Pusa, it was found that shallow furrows do not give as good results as deep ones and that deep furrows enable the soil to receive and retain nearly all the water supplied. The importance of knowing the physical characteristics of the land thoroughly to depths of 6 feet or so is emphasised. The wisdom of this remark could with profit be extended to land in India which is destined to be used for field experiments.—(A. Howard).

* * *

The Production of cigar wrapper tobacco under shade in the Connecticut Valley, J. B. Stewart, Bulletin 138, Bureau of Plant Industry, United States Department of Agriculture, December 1908.

This bulletin deals briefly with the culture, curing, packing, grading and marketing of tobacco grown under shade in the Connecticut Valley. As the conditions under which tobacco is grown in the United States are so very different from those which prevail in India, this bulletin contains little of direct application to this country. It is interesting, however, in showing how exceedingly many-sided and complex the factors are on which the successful production of high class tobaccos depends. The author concludes that tobacco can be produced profitably in the Connecticut Valley under shade, provided the grower obtains a good strain of seed and possesses the rebuisite experience.—(A. Howard).

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Behar Planters' Association, Ld.—Fifth Report of the Sirsiah Sub-Committee, January to March 1909.

Five years' research work on Indigo at the Sirsiah Station, Behar, brought the work up to the 31st March 1909. The experts in charge were Mr. Bergtheil as Director, Mr. Briggs, Chemist, Mr. McGregor, Agriculturist. An Economic Botanist was for some little time employed. Mr. Bergtheil's services were lent to the Behar Planters' Association during a portion of this period by the Imperial Department of Agriculture in India.

The Sirsiah Sub-Committee have decided to continue the research work in Indigo under Mr. Bergtheil for another five years, and it is understood that Mr. Bergtheil's services have now been permanently transferred to the Indigo Planters' Association from Pusa for research work in Indigo.

The main work of the Sirsiah Station will be henceforth devoted to the cultivation of a plant containing the maximum amount of Indigo combined with a high seed-yielding capacity, such a plant being obtained by cross-breeding and selection. Attention will also be paid to the manufacture of indigo in powder form with the help of a recently imported drying machine set up at Barah factory. It is clear that the work of a Chemist and an Economic Botanist to fulfil such work is of the greatest importance. Fully equipped field and laboratory work is, therefore, of the greatest importance.—(EDITOR).

* * *

REPORT OF THE FLAX WORK AT DOORIAH FACTORY FOR THE YEAR 1908-09 BY EMIL VENDERKERKHOVE.

MR. EMIL VENDERKERKHOVE, Flax Expert, whose services have been retained by the Behar Planters' Association for five years, has published a report of his work in 1908-09. The following points are specially dealt with :—

Imported seed.—The flax seed imported from Europe last season was found on arrival to have lost either wholly or in part its germinating power. This has not occurred before, and the Flax Expert is of opinion that it must have contained too much moisture at the time of packing which, combined with the heat of the voyage out, impaired its vitality. He advises, therefore, that all seed should be very carefully sun-dried before packing for export.

Acclimatized Seed.—The experiments to test the value of flax seed acclimatized in India had to be discontinued last season. The seed which had been grown in Behar for two seasons was destroyed after the discovery on the crop of the dangerous flax dodder (*Cuscuta epilinum*, Weihe) not previously found in this

country and which it is assumed had been brought in with a consignment of imported seed. No signs of the dodder were observed this year.

Seed Rates.—The question of seed rate per acre could not be finally settled this year owing to scarcity of good seed and unfavourable moisture conditions. For the present 115 to 129lbs. per acre of perfectly sound imported seed may be regarded as the proper seed rate.

Pulling the crop.—Three or four handfuls should be laid together to form a bundle, the latter tied tightly round its centre and stood upon its end for a day or so and then the bundles built into stacks, as explained in last year's report. The crop should be pulled when about half the seeds are turning brown in the capsules. It will be found that half of the remainder, though green at the time of pulling, will be quite good enough for sowing. From an average crop of flax four to eight maunds of seed may be saved.

Retting.—The Flax Expert does not believe in single retting (Vat process) for Indian flax. Better quality is obtained with double retting and there is no further loss. Dew retting was not successful owing to the small fall of dew last year. Next season, if sufficient water is available, various methods of retting will be tried.

Scutching.—Improvements have been effected in the scutching process, which have resulted in the elimination of the dust which previously gave trouble.

General conclusions.—No definite opinion can yet be expressed on the average quality of flax likely to be obtained in India. The flax produced has been clean and of good colour, but there has been a tendency for the fibre to become weaker than in Belgium. That may, however, have been due to unfavourable seasons, the last two having been abnormally dry.

Below is given a detailed account of expenditure on a field of flax of 23 bighas 5 kathas (a bigha being a little under one acre) at Dooriah and of the returns obtained.

				Rs.	As.	P.
Rent of land at Rs. 3 per bigha	...	...	...	69	12	0
Preparation of land at Rs. 5 per bigha	...	...	...	116	9	0
Pulling at Rs. 2-8 per bigha	...	...	...	58	2	0
Tieing up bundles at annas 10 per bigha	...	...	...	14	8	6
Stacking in field at annas 10 per bigha	...	...	...	14	8	6
Carting to store house from field 1,219 maunds, at 3 pies per md.				19	0	9
Rippling 974 maunds at 9 pies per maund			...	45	10	6
Cleaning seed 55 maunds, 33 seers, 4 chattacks at annas 3 per maund	...	...	...	10	7	0
Storing in house 974 maunds, 20 seers, at 2 pies per maund			...	10	2	3
Cost of Mooj string, etc., for tieing 974 maunds, 20 seers at 6 pies per maund	...	...	...	30	7	3
Cost of sowing with acclimatised seed 2 maunds to the bigha at Rs. 5 per maund at Rs. 10 per bigha	...	...	...	232	8	0
Total expenditure in sowing, securing crop and seed ...			...	621	11	9

	Mds.	Srs.	Chs.
Returns—Unrippled straw	1,219	0	0
Rippled straw	974	20	0
Seed	55	33	4

Manufacturing expenses of 974 maunds, 20 seers rippled straw.					
Carting to vats 974 maunds, 20 seers at 2 pies per md.	1st retting.		10	2	6
" " "	... 2nd "		10	2	6
Loading and taking out at 1 pie per maund	... 1st "		5	1	3
" " "	... 2nd "		5	1	3
Carting from vats to drying ground at 2½ pies per maund after	... 1st "		12	11	0
Carting from vats to drying ground at 2½ pies per maund after	... 2nd "		12	11	0
Spreading flax at 1½ pies per maund	... 1st time		6	5	6
" " ...	... 2nd "		6	5	6
Turning over flax at 1½ pies per maund	... 1st "		6	5	6
" " ...	... 2nd "		6	5	6
Tieing up at 1½ pies per maund ...	... 1st "		7	9	9
" " ...	... 2nd "		7	9	9
Sundries in drying field	...	...	5	2	0
	Total	...	101	9	0
Carting from field to breaker at 1½ pies per maund	...	...	7	9	9
Scutching 104 maunds flax at Re. 1-7 per maund	...	...	149	8	0
Breaking at 8 pies per maund	...	...	40	9	6
Scutching 50 maunds, tow at 5 annas per maund	...	...	15	10	0
Wages of Mistries	...	...	4	10	0
Cost of watering vats	...	...	6	5	6
Total manufacturing expenses	...	...	366	13	9

Returns—104 maunds flax.
11 „ Tow during two last scutchings.
50 „ „ „

Baling and Freight.

	Rs.	As.	P.
Baling and freight from Dooriah to Dundee, at Rs. 3 per maund,			
104 maunds flax	312	0	0
61 maunds tow	183	0	0
	495	0	0
Add cost of sowing, securing and seed crop	621	11	9
Add manufacturing expenses	366	13	9
Total ..	1,483	9	6

Returns and Value.

104 maunds flax at £50 per ton or Rs. 27-9-0 per maund ...	2 866	8	0
61 maunds tow at average £20 per ton or Rs. 11 per maund ...	671	0	0
Seed 55 maunds, 33 seers, 4 chats, at Rs. 5 per maund ...	278	13	0
Total ...	3,816	5	0
Less cost ...	1,483	9	6
Nett profit ...	2,332	11	6

Size of field bighas ...	Rs. 23	5	0
Profit per bigha ...	„ 100	5	3
„ acre ...	„ 115	5	0

There was much loss of seed in this field, but with efficient labour, about five maunds more of seed per bigha (= Rs. 25) might be saved. This would add Rs. 18 (after deducting the cost of securing this extra seed) to the net profit per bigha. This cost of sowing per bigha would be more than Rs. 7 if, in every third year, the seed is to be imported from Europe at a cost of about Rs. 15 per maund.—(EDITOR).

LIST OF AGRICULTURAL PUBLICATIONS IN INDIA FROM THE 1st FEBRUARY TO 31st JULY 1909.

No.	Title.	Author.	Where published.
		General Agriculture.	
1	*Agricultural Journal of India*, Vol. IV, Parts II & III. Price Rs. 2 a copy. Annual subscription, Rs. 6.	Agricultural Research Institute, Pusa.	Messrs. Thacker, Spink & Co., Calcutta.
2	Note on the Extension of Cultivation of Fibre plants in India, Bulletin No. 15 of the Agricultural Research Institute, Pusa. Price 6 annas.	Board of Agriculture in India for 1908.	Government Printing, India, Calcutta.
3	Maize, Leaflet No. 1 of 1909 ...	F. Smith, B.Sc., Deputy Director of Agriculture, Bengal.	Department of Agriculture, Bengal.
4	Juar and Fodder Crops in Bengal, Leaflet No. 2 of 1909.	Ditto.	Ditto.
5	Note on the Soils of Bengal ...	D. N. Mukerjee, M.A., M.R.A.C., M.R.A.S.	Bengal Secretariat Press, Calcutta.
6	Sugarcane and Sugarcane Experiments in Bengal, Leaflet No. 4 of 1909.	F. Smith, B.Sc., Deputy Director of Agriculture, Bengal.	Department of Agriculture, Bengal.
7	*Aus, Bhadoi*, early or Summer paddy (rice), Leaflet No. 5 of 1909.	Ditto.	Ditto.
8	Season and Crop Report of Bengal, 1908-09.	Department of Agriculture, Bengal.	Bengal Secretariat Press, Calcutta.
9	*Quarterly Journal*, Vol. II, Nos. 3 and 4. Price 8 annas per copy.	Ditto.	Ditto.
10	Annual Report on the Aligarh Agricultural Station for the year ending 30th June 1908. Price 8 annas.	Department of Land Records and Agriculture, U. P.	Government Press, Allahabad.
11	Pamphlet on Groundnut and the Method of its Cultivation in Urdu and Hindi.	Ditto.	Newal Kishore Press, Lucknow.
12	List of Improved Agricultural Implements, recommended by the Department of Agriculture, Panjab, Bulletin No. 1 of 1909.	Department of Agriculture, Panjab.	*Civil and Military Gazette* Press.
13	Cultivation of Broach Cotton in Dharwar, Bulletin No. 33 of 1909. Price 4 annas.	M. L. Kulkarni, Divisional Inspector of Agriculture, S. D., Bombay.	Government Central Press, Bombay.
14	Cattle of Southern India, Agricultural Bulletin No. 60. Price Rs. 2.	Lieutenant-Colonel W. D. Gunn.	Government Press, Madras.
15	Note on Banku Paddy in English and Tamil.	H. C. Sampson, B.Sc., Deputy Director of Agriculture, Madras.	Ditto.

LIST OF AGRICULTURAL PUBLICATIONS—*contd.*

No.	Title.	Author.	Where published.
		General Agriculture—contd.	
16	Report on the Working of the Civil Veterinary Department, Central Provinces, for the year ending 31st March 1909. Price Re. 1 per copy.	Department of Agriculture, C. P.	Secretariat Press, Nagpur.
17	Leaflet on Ransome's Turn Wrest Plough in English, Hindi and Marathi.	Ditto.	Ditto.
18	Leaflet on Buri Cotton in English, Hindi and Marathi.	Ditto.	Ditto.
19	Leaflet on the Cultivation of Groundnut in Marathi and Hindi.	Ditto.	Ditto.
20	Pamphlet on more deadly forms of Cattle Diseases in Marathi. Price 4 annas a copy.	Department of Agriculture, C. P.	Secretariat Press, Nagpur.
21	*Agricultural Gazette*—monthly, from February to July 1909. Price 2 annas per copy.	Ditto.	*Deshsewak* Press, Nagpur.
22	Principal Fatal Diseases of Cattle, Veterinary Leaflet No. 1 of 1909, in English, Bengalee, Assamese and Khasi.	S. G. Hart, I.C.S., Director of Agriculture, E. B. & Assam.	Government Press, E. B. & Assam.
23	Precautions necessary to prevent the spread of Contagious Diseases, Veterinary Leaflet No. 2, in English, Bengalee, Assamese and Khasi.	W. Harris, Superintendent, C. V. D., E. B. & Assam.	Ditto.
24	Rinderpest, Veterinary Leaflet No. 3, in English, Bengalee, Assamese and Khasi.	Ditto.	Ditto.
25	Foot-and-Mouth Disease, Veterinary Leaflet No. 4 in English, Bengalee, Assamese and Khasi.	Ditto.	Ditto.
26	The Use of Small Bullock Hoe, Cultivator's Leaflet No. 16.	Department of Agriculture, Burma.	Government Press, Burma, Rangoon.
27	Climatological Tables for Burma, Bulletin No. 2 of the Department of Agriculture, Burma.	F. J. Warth, M.Sc., Agricultural Chemist, Burma.	Ditto.
		Agricultural Chemistry.	
28	The System Water, Calcium Carbonate, Carbonic Acid, Memoirs of the Imperial Department of Agriculture, Vol. I, No. VII. Price Re. 1	J. Walter Leather, Ph.D., F.I.C., F.C.S., and Jatindra Nath Sen, M.A., F.C.S.	Messrs. Thacker, Spink & Co., Calcutta.
		Mycology.	
29	The Mulberry Disease caused by Coryneum Mori Nom. in Kashmir with notes on other Mulberry Diseases, Memoirs of the Imperial Department of Agriculture, Vol. II, No. 8. Price Re. 1-8.	E. J. Butler, M.B., F.L.S., Imperial Mycologist, Pusa.	Ditto.
30	Pamphlet on Preservation of Smut in Urdu and Hindi.	Department of Land Records and Agriculture, U. P.	Newal Kishore Press, Lucknow.
31	The *Ufra* Disease of Rice, Leaflet No. 1 of 1909.	S. G. Hart, I.C.S., Director of Agriculture, E. B & Assam.	Government Press, E. B. and Assam.

LIST OF AGRICULTURAL PUBLICATIONS—*contd.*

No.	Title.	Author.	Where published.
		Economic Botany.	
32.	Some Experiments in the Hybridising of Indian Cottons, Memoirs of the Imperial Department of Agriculture, Vol. II, No. 6. Price Re. 1-8.	P. F. Fyson, B.A., F.L.S.	Messrs. Thacker, Spink & Co., Calcutta.
33	The Varietal Characters of Indian Wheats, Memoirs of the Imperial Department of Agriculture, Vol. II, No. 7. Price Re. 1.	A. Howard, M.A., F.L.S., and G. L. C. Howard, M.A.	Ditto.
34	A Note on the Preparation and Packing of Specimens of Plants and Insects, Leaflet No. 3 of 1909.	E. J. Woodhouse, B.A., Economic Botanist to the Government of Bengal.	Department of Agriculture, Bengal.
		Entomology.	
35	Leaflet on the Juar Stem borer in English, Hindi and Marathi.	Department of Agriculture, C. P.	Secretariat Press, Nagpur.
36	The Palm Beetle or Rhinoceros Beetle, Cultivators' Leaflet No. 17.	Department of Agriculture, Burma.	Government Press, Rangoon.
37	Granary Pests, Bulletin No. 1. (*In the press*).	Ditto.	Ditto.
38	*Indian Insect Life.* Price Rs. 20.	H. Maxwell-Lefroy, M.A., F.E.S., F.Z.S., Imperial Entomologist, Pusa, and F. M. Howlett, Second Entomologist.	Messrs. Thacker, Spink & Co., Calcutta.

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